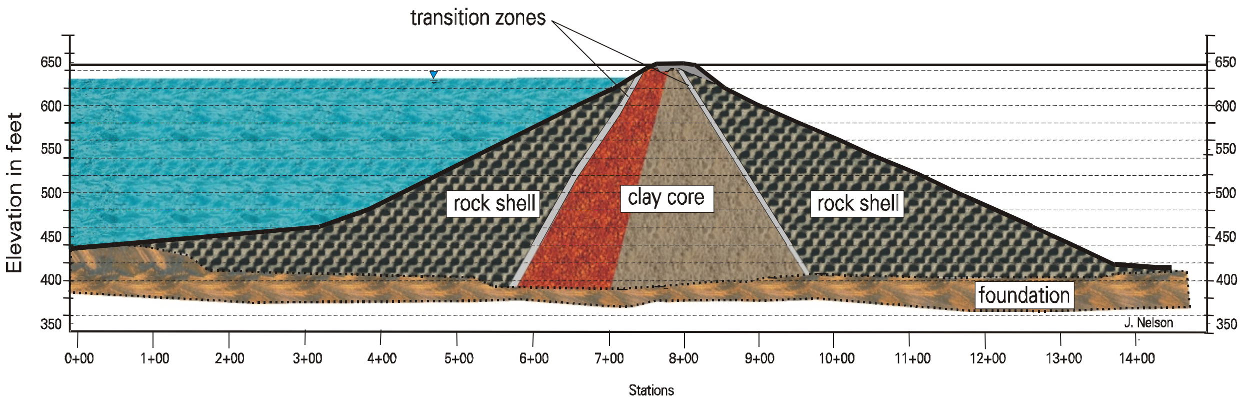
February 2007

SECOND SUMMARY SURVEILLANCE REPORT
October 2004 through December 2006
LEROY ANDERSON DAM NO. 72-9,
Santa Clara County



WATER – OUR MISSION FOR 75 YEARS

Santa Clara Valley Water District℠

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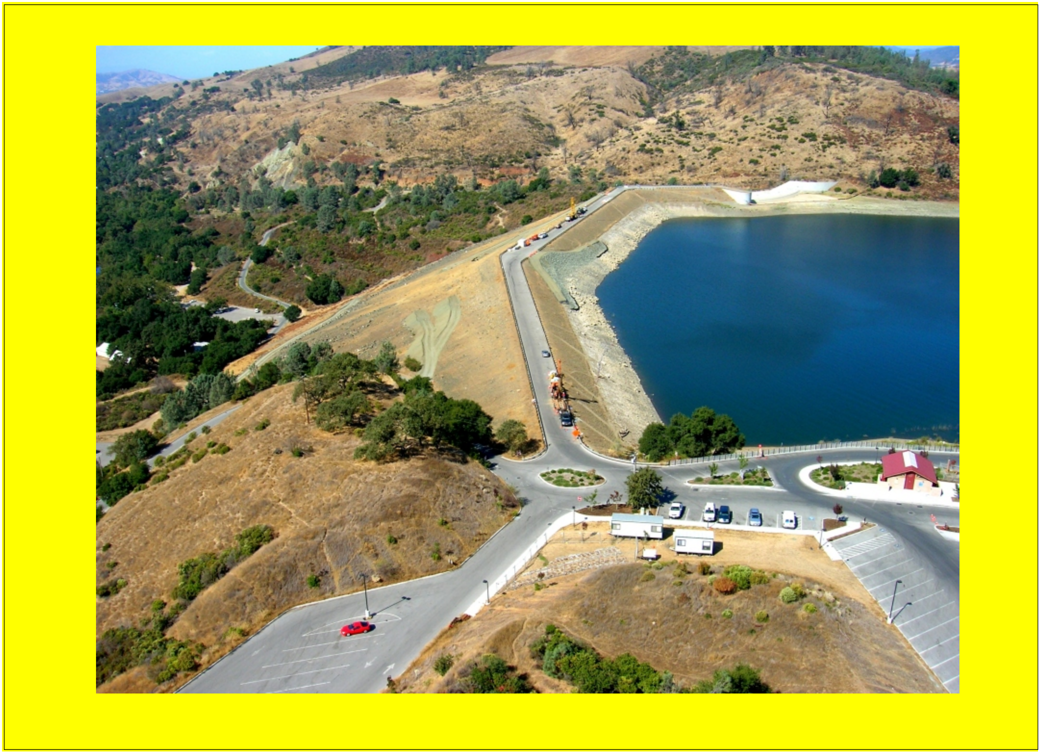

Date of photo 10/10/06
Photo shows temporary drill rig access roads and 2 drill rigs on dam crest for DIP

Prepared for:

State of California
Department of Water Resources
Division of Safety of Dams
P.O. Box 942836
Sacramento, CA 95236

Prepared by:

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February 2007

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February 15, 2007

Mr. David A Gutierrez, Chief
Division of Safety of Dams
Department of Water Resources
1416 Ninth Street
P.O. Box 942836
Sacramento, CA 94236-0001

Subject: Leroy Anderson Dam, No. 72-9, Santa Clara County
Oct. 2004 to December 2006, Second Summary Surveillance Report

Dear Mr. Gutierrez:

Please find enclosed two copies of our second summary surveillance report for Leroy Anderson Dam covering the period from October 2004 to December 2006. There were no major incidents or changes at the dam during 2006. In general, there are no substantive changes in dam or reservoir response from previous years, except that the reservoir spilled for about 1 week in early April 2006.

This report includes an analysis of data from 2 pneumatic piezometers in the dam, one open well piezometer near the downstream toe, 2 spillway underdrain seepage weirs, 15 dam crest survey monuments, and 3 spillway training wall survey monuments. A goal for the District's summary reports presented every five years is to attempt to retrieve and present any previously unpublished surveillance data, plus the opportunity to present a more thorough discussion of the surveillance data over that provided in the Interim Reports published more or less annually. For this report, the District discovered some previously unpublished piezometer data for pneumatic piezometers PPA-1 and PPA-2 dating back to late 1975. In this summary report we present new interpretations of the historic response of these pneumatic piezometers.

Interpretation of the surveillance data from Leroy Anderson Dam and the District's field observations confirm acceptable performance of the dam and spillway for the period of this report. Piezometer and weir data will continue to be measured monthly, and crest and training wall monuments will be surveyed annually.

On November 9, 2005, and August 31, 2006, the dam was inspected by various District staff, including the authors of this report, in addition to DSOD engineer Mr. Aspet Ordoubigian. A brief field inspection was also made by Mr. Stan Wallis on June 15, 2006 following a M4.7 event that had occurred earlier that morning and had its epicenter located 9 miles southeast of Leroy Anderson Dam. Based on these field observations, and our interpretation of the instrumentation data presented herein, Leroy Anderson Dam appears to be performing satisfactorily.

WATER – OUR MISSION FOR 75 YEARS

If you have any questions or comments regarding our surveillance program in general, or this report in particular, please contact Mr. Richard L. Volpe, Senior Engineer, Dam Safety Group, Infrastructure Planning Unit, (408) 265-2607, extension 2602.

Sincerely,

David E. Hook, P.E.
Engineering Unit Manager
Infrastructure Planning Unit

Enclosures

cc: w/encl. J. Aguilera, D. Gilleland, D. Hook , R.L. Volpe, J. Nelson, M. Mooers, S. Wallis, library (4 copies), Records Management
w/o encl. R. Yep

SECOND SUMMARY SURVEILLANCE REPORT
October 2004 through December 2006
LEROY ANDERSON DAM NO. 72-9,
Santa Clara County

The interpretation of the instrumentation and other relevant data presented in this report has involved the application of certain graphical and statistical interpretive techniques common to the geosciences and earth dam engineering professions. The conclusions presented in this report were developed upon evaluating the performance of all instruments and other pertinent surveillance data collected during the specified period, and represent the professional judgment of its authors. This report was submitted on February 15, 2007.

Report prepared by:

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Richard L. Volpe

Richard L. Volpe, P.E, G.E.
Senior Engineer
Infrastructure Planning Unit

Quality Control/Quality Assurance

This report has been reviewed and approved for publication by the undersigned professional engineer. I attest and confirm that the report was prepared by the individuals who signed the report under my immediate direction and supervision and that the conclusions and recommendations presented herein are reasonable and supported by District management.

Reviewed and approved by:

David E. Hook

David E. Hook, P.E.
Engineering Unit Manager
Infrastructure Planning Unit

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ATTACHED CD:

Raw Survey Data (DSOD copy only)

1.0 INTRODUCTION

1.1 Scope and Purpose

This Second Summary report summarizes the Santa Clara Valley Water District's (District) evaluation of Leroy Anderson Dam and reservoir located in southern Santa Clara County, California, for the surveillance period from October 2004 through December 2006. The First Summary report for Anderson Dam was published in March 2001 (Nelson and Volpe, 2001). Summary Reports are intended to provide extensive analysis and evaluation of the surveillance data, along with detailed pertinent discussions of data analyses over a period of about 5 years.

A goal for the District's summary reports presented every five years is to attempt to retrieve and present any previously unpublished surveillance data. For this report, the District retrieved some unpublished piezometer data for pneumatic piezometers PPA-1 and PPA-2 dating back to mid-1975, shortly after the pneumatic piezometers were installed. A plot of these data is shown on Figure 5.

2.0 BACKGROUND INFORMATION AND METHODOLOGY

During the time period covered by this report, the District monitored 2 pneumatic piezometers in the dam, one open well piezometer near the downstream toe, 2 spillway underdrain seepage weirs, 15 dam crest survey monuments, and 3 spillway training wall survey monuments. The physical locations of crest monuments, spillway training wall monuments, piezometers, accelerometers, and the spillway underdrain weirs discussed herein are shown in plan in Figure 1, and in section on Figure 2. Specifically, Figure 2 presents a longitudinal and transverse cross section near the maximum section of the dam and shows the locations of the dam's two pneumatic piezometers and open well piezometer OW-1.

All new data covered in this report is presented in tabular form, and plotted to facilitate review. Tables 1 through 3 summarize recent piezometer, weir, and surface monument survey data, respectively. All surveillance data are also shown graphically on Figures 3 through 17, and discussed later in the report. For the period of this report, data were collected monthly for piezometers and weirs. Crest monuments were surveyed at the times indicated (typically near the end of every year).

All elevation data have been adjusted for the current datum used by the District which is the North American Vertical Datum (NAVD) 1988, which is 2.80 feet higher than the old datum (NGVD) at this location.

2.1 General Surveillance

The physical locations of instruments referenced herein are shown in plan in Figure 1, and in sections on Figure 2.

Tables 1 through 4 summarize recent piezometer, spillway weir discharge, crest surface monument survey, and spillway training wall monument survey data, respectively. All tabular surveillance data are also shown graphically on Figures 3 through 17, and our interpretation of their significance is discussed later in the report.

2.2 Piezometers

Both pneumatic piezometers (PPA-1 and PPA-2), originally installed in 1975, show slight fluctuations and response to changes in reservoir levels. A gap in the data occurs from December 2001 through March 2002 due to problems with the pneumatic data collection instrument. In September 2003 the District began collecting water level data from open well piezometer OW-1 after it was installed in August 2003.

2.3 Spillway Underdrain

The current spillway underdrain seepage monitoring program for Anderson Dam Spillway began in May 1993. At that time, the District only measured the "center" drainage system which collects seepage from the 1988 extended spillway slabs starting at the downstream (D/S) toe of the spillway crest and extending left to within 30 feet of the left training wall and D/S to the dentated spillway bucket. The drainage system was comprised of 4-in. lateral perforated pipe drains connecting to a longitudinal drain consisting of 6-in., 8-in. and 12-in. perforated pipe measured through a flow meter. The "left" drainage system discharged through boulders that were providing slope protection D/S of the spillway bucket and could not be measured.

The seepage system was modified with the construction of the two "V" notch seepage weirs in 1999 (with readings beginning April 2000) to allow for independent and unrestricted measurement of flows. Weir #1 continues to measure the seepage from the "center" drainage system but is not affected by the restriction and backpressure created by the use of a flow meter as was the old system that it replaced. Weir #2 measures the seepage starting at the D/S toe of the spillway crest and extending 30 feet to the right of the left training wall and D/S to the spillway bucket. The drainage system is comprised of 4-in. lateral perforated pipe drains connected to a longitudinal drain consisting of 6-in., 8-in. and 12-in. perforated pipe.

2.4 Monuments

Modifications to Anderson Dam in 1988 included raising the dam crest 4 to 7 feet and widening of the spillway to accommodate new PMF discharge requirements. Figure 1 shows the general outline of the 86-87 dam raise. Consequently, new monuments were installed in 1988 along the crest and at the right and left abutments. Unlike other District dams, the locations of the survey monuments at Anderson Dam alternate from the upstream to downstream side of the crest.

Before 1988 and the introduction of GPS surveys with the resulting data provided in the form of coordinates (Northings and Eastings), previous transverse data consisted of offset displacements either upstream or downstream relative to the monument line established soon after the dam was constructed. To conform to the format of surveillance reports for other District dams, we now provide transverse monument data. These data are calculated from the coordinate data using trigonometric relationships assuming stable reference points away from the dam at the right and left abutments. It should be noted that transverse displacement is not applicable to the training wall monuments because they are not aligned along a single line-of-sight. Consequently, we are only providing vertical training wall data.

As discussed below in more detail, to further simplify our annual interim surveillance reports, we have made a significant change in the way that yearly survey data are presented in both tables and data plots. In addition, beginning with this report, we are providing DSOD with an electronic copy of raw survey data consisting of monument Northings, Eastings, and Elevations from 1988 to 2005 on a CD as an attachment.

Survey of monuments at Anderson Dam consists of using GPS techniques with data format in X-Y coordinates (eastings and northings, respectively). Previous survey techniques of the original crest monuments consisted of offset (transverse) displacements either upstream or downstream relative to the monument line established soon after the dam was constructed. These data are calculated from the coordinate data using trigonometric relationships assuming stable reference points away from the dam and located in the right and left abutments. The reference baseline for the transverse displacement calculation uses the coordinates of the end points, assumed to be relatively stable monuments in bedrock immediately right and left of the dam, at the time the survey was first established. It should be noted that the GPS survey (northing, easting, and vector displacements) do not utilize local stable endpoints, but a regional GPS station, and thus produce somewhat different results with respect to points of reference.

2.4.1 Resultant Lateral Displacement using Double Differences

In this report we introduce a new method of analyzing survey data (developed by R.L. Volpe and J.L. Nelson) to determine resultant lateral displacement using a calculation method referred to as the Resultant Double Differences (RDD). This method involves calculating the cumulative change in distance in the X (eastings) and Y (northings) directions between a reference monument on a particular structure and each successive monument in-line with the reference monument. The final result of the RDD method is a plot of resultant cumulative displacement between monuments versus time determined across the entire length of the structure being analyzed. The RDD method is useful for determining local deformation between individual monuments and progressive deformations across the entire length of various instrumented structures at Anderson Dam, including the dam crest, spillway floor, and outlet works. It tends to mask other minor survey differences.

The new RDD method was developed because our previous analyses of GPS-based coordinate survey data appeared to indicate systematic and other minor errors that impacted our interpretation of annual survey data. Possible causes for these other errors include minor movements of control monuments due to regional tectonics, minor creep of monuments situated on sloping ground, or the sighting of monuments over relatively long distances. Favorable outcomes of the RDD method are that systematic errors and apparent movements due to regional tectonic movements and changes in datum appear to be largely cancelled out. Consequently, the only movements detected by the RDD method are actual displacements occurring within the structure itself.

Increasing (positive) RDD values indicate a monument is moving away from the reference monument and decreasing (negative) RDD values indicate a monument is moving toward the reference monument. Movements away from a reference monument can occur due to relative extension (i.e. tension, pulling away) or due to lateral (right or left) separation between the monuments. Movements toward the reference monument can occur due to relative compression, or due to thrust fault-type displacement between the monuments. RDD values that do not change indicate that no lateral movement is occurring between monuments.

The RDD method involves calculating two sets of differences data. The first set of data are the distances, calculated as the difference between coordinates of a selected reference monument typically at one end of the particular structure, and the successive monuments situated at progressively greater distances from the reference monument. Specifically, differences are calculated between respective northings (Y) values and eastings (X) values. Following determination of the differences in northings and eastings, there are three additional steps to the RDD method of analysis. The second step of the analysis involves computing the cumulative difference between the initial data set and successively more recent data sets for each monument. The third step involves calculating the resultant displacement (vector addition) of each data set based on the cumulative difference values of northings and eastings from step 2. The final step is to plot resultant displacement versus time to visually display resultant changes in distances between the reference monument and other in-line monuments.

Beginning with this report, the District will present the RDD results for all survey monuments (dam crest, spillway floor, and outlet works) along with a brief discussion of any apparent trends. We have back-calculated the previous data sets, so that the graphs presented over time are all based on the new RDD method.

2.4.2 Discussion of Methods for Determining Lateral Displacements

We use the following three methods for determining lateral displacements of crest monuments in this and past surveillance reports.

1) The original method used since dam construction in 1936 is the "transverse" method (i.e. station and offset), which is based on trigonometric calculations assuming two stable reference points at the ends of the embankment. One limitation of this method is that only displacements situated at right angles to the crest (i.e. upstream and downstream) are detected.

2) The second method calculated resultant vector displacement (hereafter termed "vector method") based on X (eastings) and Y (northings) coordinates from GPS survey data with a fixed reference point northeast of the dam. Resultant vectors are calculated by vector addition of northings and eastings. One limitation of this method is that slight movements of bench mark reference monuments located far away from the dam introduce errors in the analysis.

3) The third and newest method designated as the Resultant Double Difference (RDD method) also calculates resultant displacement based on X and Y coordinates, but filters out extraneous errors by comparing displacement relative to single reference monument at the right abutment end (northeast) of the dam. A favorable outcome from the vector method and RDD method is that displacements can be detected in any direction in the X-Y plane.

We believe the RDD method provides more realistic results than the older transverse and vector methods of determining lateral movements. The movements calculated from the transverse method are somewhat 'artificial" because only movements occurring at right angles to the line between the stable reference points are detected. Because of the direct comparison between successive monuments, the RDD method will more readily detect movements within the structure itself.

The sign convention for the original transverse method is that negative displacements indicate relative downstream displacement and positive displacements indicate upstream displacement. For this sign convention, the assumed fixed reference point is situated left of the dam. The sign convention is opposite for the other two methods (vector and RDD) that have assumed fixed reference points situated right of the dam.

2.4.3 Dam Crest and Abutment Monuments

The crest monuments generally alternate between the downstream edge and upstream edge of the crest. Data plots have been grouped as either "upstream (U/S) edge" or "downstream (D/S) edge". The location of the surface monuments are shown on Figure 1.

As noted in a previous reports (Nelson and Mooers, 2003; 2004) because mon #31 was destroyed during the 2003/2004 boat ramp construction, the new left abutment endpoint will be mon #30 in the U/S and D/S monument groups (as noted above in Section 4.0, mon. #30 is a new control point for determining local transverse displacement).

2.4.4 Spillway Training Wall Monuments

Three survey monuments are located at the top of the spillway training walls, two on a wall on the left side of the spillway ogee (#14 and #15), and one on a wall on the right side of the ogee (#13), as shown on Figure 1. It should be noted that mon. #13, on the right spillway wall, has not been monitored since October 2001 because of difficult access for the surveyors. Also, it recently came to our attention that previous spillway training wall horizontal and vertical survey results may be questionable. The training wall monuments are located adjacent to chain link fences and are thus difficult to access (see Nelson and Mooers, 2004 for more information). The District is currently taking measures to address and correct this issue.

3.0 SURVEILLANCE DATA

3.1 Annual Reservoir Fluctuation

Figure 3 shows the detail of reservoir fluctuation during most of calendar year 2006 (gray shading). Boat ramp construction and below normal rainfall from 2001 to 2004 contributed to lower reservoir levels prior to the 2004-05 winter. As indicated in Figure 3, reservoir levels have returned to normal due to relatively normal rainfall in 2005 and 2006 (~16 inches cumulative rainfall from Jan 2005 through Dec 2006 in the Anderson watershed area). The preponderance of rainfall occurred during January 2006 through April 2006.

As shown in Figure 3, during 2006 Anderson reservoir experienced a relatively uniform rise-and-fall in water levels due to a fair amount of rainfall early in the winter. Anderson Reservoir began the calendar year at about el. 607.35 feet, or ~18 feet below spillway crest (el. 627.8). By early March 2006, the reservoir had experienced a gradual rise of ~6 feet to el. 613.5. Thereafter the reservoir rose approximately 15 feet at a rate of ~0.4 ft/day until it reached an elevation of 628 feet on April 6, 2006. At this time the reservoir began to spill and continued spilling for about 6 days, from April 6, 2006 through April 13, 2006. This is the first time Anderson Reservoir spilled since the winter of 1997-98. The reservoir fluctuated within about 1 foot of the spillway crest until early June. From June 2006 through September 2006 reservoir levels dropped approximately 20 feet at a rate of ~0.2 ft/day. The lowest reservoir level was ~el. 604 (~24 feet below spillway crest) on October 30, 2006. Due to minor rainfall in November 2006, the reservoir rose about 2 feet to ~el. 607 and stayed at this level through the end of 2006.

3.2 Piezometers

Figure 4 shows both pneumatic and open well piezometric levels, reservoir levels, and monthly rainfall data from January 1994 through December 2006. Table 1 and the gray area of Figure 4 show data since our 2004 report.

Overall, the data indicates that fluctuations in piezometric levels show a very muted response to fluctuations in reservoir level.

Pneumatic piezometers PPA-1 and PPA-2 consistently show minor variations in piezometric elevations, under wide range in reservoir fluctuations, and appear to be providing reliable and consistent data during the entire surveillance period. Since installation, open well OW-1 has consistently ranged between ~el. 403.7 feet and 406 feet, or ~10 feet to 11 feet below ground surface. The low value for 2005 marks the first time the elevation in OW-1 has dropped below ~405.5 feet. This drop does not appear to correspond to reservoir elevations which, as mentioned above, actually rose to normal levels in 2005. For 2006, piezometric elevations in OW-1 were consistently ~406 feet, which corresponds to a depth of ~10 ½ feet below ground surface. It appears possible that because piezometric surface elevations (PSE) in OW-1 do not respond or correlate to reservoir fluctuations, the measured PSEs may be related to the local groundwater table.

3.1.1 Discussion of Historic Pneumatic Embankment Piezometer and Open Well Piezometer Responses

Figure 5 is an historic plot of pneumatic piezometric response of Anderson Dam piezometers PPA-1 and PPA-2 from recently retrieved historic piezometer data. Figures 6, 7, and 8 are historic cross plots of reservoir elevation versus Piezometric Surface Elevations (PSE) for PPA-1, PPA-2, and OW-1, respectively. The cross plots show historic upper and lower boundaries, best-fit lines through the data, and recent 2006 data for both reservoir rising and reservoir falling. Reservoir falling data typically plots at slightly higher elevations than reservoir rising data because the embankment is more saturated and experiences a higher phreatic zone as water levels fall relative to when water levels rise. The best-fit range of historic reservoir rising and falling is shown on Figures 6 through 8 as a cross hatch pattern. The cross-plots are useful for tracking historic trends and for quickly evaluating whether a given PSE data point is reasonable, is a sign of adverse conditions, or is spurious. Based on the cross plots (Figures 6 through 8), the piezometric data for 2006 falls well within the historic range.

As shown in Figure 2, PPA-1 is located in the central clay core with a tip elevation of 542.8 feet, or 104 feet below the spillway lip elevation. The piezometer tip is located along the dam centerline and about 100 feet horizontally from the rock shell (Zone 1). As shown in Figure 6, the maximum piezometric surface elevation (PSE is defined as piezometer tip elevation plus the measured pressure head in feet) occurs shortly after the maximum reservoir head occurs (spillway lip of elevation 627.8 feet) and is equal to about elevation 586 feet, thus indicating a loss of about 42 feet of pressure head due to seepage through the core. In terms of the maximum total head, assuming the reservoir bottom at about elevation 450 feet, the maximum pressure head acting against the upstream core is about 178 feet (elevation difference between spillway lip and reservoir bottom). PPA-1 measures about 51% of the maximum reservoir head acting against the upstream face of the central clay core on a horizontal plane passing through the elevation of the tip. This indicates that about 49% of the maximum pressure head has been lost due to seepage by the time the flow reached PPC-1.

As shown in Figure 2, PPA-2 is located in the same drill hole as PPA-1, but is 105 feet deeper in the core with a tip elevation of 437.8 feet, or about 190 feet below the spillway lip elevation. PPA-2 is located with its lower sensing zone about 9 ½ feet into bedrock and its upper sensing zone about 51 ½ feet into the embankment core. The piezometer tip is located about 200 feet horizontally from the rock shell (Zone 1). As shown in Figure 7, the maximum PSE occurs shortly after the maximum reservoir head occurs (spillway lip of elevation 627.8 feet) and is equal to about elevation 505 feet, thus indicating a loss of about 123 feet of pressure head due to seepage through the core. In terms of the pressure head, the maximum pressure head for PPC-2 is about 35% of the maximum reservoir head acting against the upstream face of the central clay core on a horizontal plane passing through the elevation of the tip. This indicates that about 65% of the maximum pressure head has been lost due to seepage by the time the flow reached PPA-2.

As shown in Figure 2, OW-1 is located about 650 feet downstream of the dam crest and is founded in alluvium with a tip elevation of 398.8 feet, or about 229 feet below the spillway lip elevation. As shown in Figure 4, the maximum PSE for OW-1 does not appear to respond to the maximum reservoir head or to seasonal changes in reservoir levels. The maximum PSE is equal to about elevation 406 feet, thus indicating a loss of about 222 feet of pressure head due to seepage through the core and foundation. In terms of the pressure head, the maximum pressure head for OW-1 is about 3% of the maximum reservoir head acting against the upstream face of the central clay core and foundation on a horizontal plane passing through the elevation of the tip. This indicates that about 97% of the maximum pressure head has been lost due to seepage by the time the flow reached OW-1. Because of the overall lack of response of OW-1 to reservoir levels, there does not appear to direct connectivity between the reservoir foundation and the alluvial foundation situated at the downstream toe of the dam.

Based on the piezometer data results presented in this section, it appears that the maximum reservoir head is dissipated through seepage losses across the core, although critical information from pneumatic piezometers, especially within the core is lacking. It is hoped that the response of the new vibrating wire piezometers presently being installed (Fall 2006/Winter 2007) within the dam and foundation will provide a clearer definition of the variation in piezometric pressure acting across the core and within the foundation.

3.3 Spillway Underdrain Flow

Figure 9 shows spillway underdrain flow data from 1993 through 1998, along with reservoir levels, monthly rainfall and data from the new weirs from April 2000 through December 2006. As mentioned above, the District installed two new weir structures in 1999 that collect underdrain flow from two main underdrain exit points. The former underdrain flow meter appears to have been measuring a total flow of only about 1/2 of the total underdrain flow that is now being measured.

During 2006 the combined flow from the weirs ranged from a low of 0 gpm (June 2006 through September 2006) to a high of 475 gpm measured on April 17, 2006. This represents the highest seepage value recorded since the new weirs were installed. The high weir flow generally coincided with the highest reservoir excursion that resulted in reservoir spillage from April 6, 2006 through April 13, 2006.

Starting with this annual report we are presenting Figure 10, which is a cross-plot of reservoir elevations versus spillway underdrain flow in gallon per minute (gpm). Figure 10 shows three groupings of data, which include historic total weir discharge range (cross-hatch pattern), weir No. 1 discharge range (light blue shade), and weir No. 2 discharge range (pink shade). As seen in Figure 10, Weir #1 represents the preponderance of the total flow. Also, a comparison of discharge from the two weirs indicates the following trends: (1) discharge flow from weir No. 1 initially increases more rapidly than weir No. 2 starting at reservoir elevations greater than ~el. 595 ft. (2) the relative rate of discharge from weir No. 1 decreasing somewhat at reservoir elevations greater than ~el. 610 ft. (3) the relative rate of discharge flow from weir No. 2 is initially relatively low with the rate increasing at reservoir elevations greater than ~el. 610 ft.

3.4 Crest And Spillway Training Wall Monuments

For the current surveillance period, the monuments were surveyed on October 31, 2006.

The terrestrial survey performed at Anderson Dam is based on using conventional GPS techniques to establish current coordinates (northing and easting) for the local bench mark (Monument 393) used for the survey. This is accomplished by using the known coordinates of benchmarks located reasonably close (typically within 1 to 2 miles) to the site. The last date for which accurate county-wide GPS surveys were performed to establish the benchmark coordinates is referred to as an "epoch" date. The last such epoch date for the area around Anderson Dam was in 1991. A new epoch survey within the county was performed in 2004. During the intervening 13 years between epoch surveys, the computed average lateral shift for all dam monument was N = 0.95 ft and E = 0.90 ft. It is believed that a majority of the inferred movement is due to local tectonic movement associated with the San Andreas and Calaveras faults. In addition, there was an approximate 0.04 ft (0.48 in) apparent heave between the epoch surveys.

3.4.1 Local Transverse Displacement

Table 3 summarizes new vertical and "local transverse displacement" data for the crest and abutment monuments. Beginning with this report, the tabulated survey data (Table 3) include a row that shows the average change since last survey, for each data set.

As stated above, in our annual reports we are no longer including summaries of recent northings, eastings, and resultant vector survey data for monuments.

Figures 11 and 12 are plots of resultant displacement relative to Mon 16, using Resultant Double Difference (RDD) methods, for downstream and upstream monuments, respectively. The RDD method is discussed in detail in section 2.4.1, Resultant Lateral Displacement using Double Differences. Figures 11 and 12 are new plots as indicated by gray shading.

Figures 13 and 14 are plots of recent local transverse vector displacements of the downstream and upstream monuments, respectively, from November 2005 to October 2006.

The data presented indicates essentially no significant local transverse (perpendicular to the crest) displacements (zero to 0.02 ft, or 0.24 in) have occurred during the current period.

As suggested by Figures 11 and 12, since the dam raise in 1988, the overall historic downstream displacements of mons. 19, 21, 23, and 24 appear to generally correlate with fluctuations in reservoir elevations. Except for mon 23, these mons are predominantly situated along the downstream edge of the crest. All these monuments are situated right of the dog-legged portion of the dam crest (when looking downstream). From 1988 to 1993 the reservoir was kept relatively low (generally below elev. 560 ft). During this period the crest monuments showed minimal displacements downstream. Monuments 19, 21, 23, and 24 began to exhibit noticeable downstream displacements from 1993 to 2000, which corresponds to a period of relatively high reservoir levels. A significant drop and rise in reservoir elevations occurred from 2000 to 2006. During this period displacement of the affected monuments proceeded slightly upstream and then experienced minor displacements downstream (Figures 11 and 12).

3.4.2 Vertical Displacement

Table 3 summarizes new vertical displacement data for the crest and abutment monuments and Table 4 summarizes new vertical displacement data for the spillway monuments.

Figures 15, 16, and 17 shows plots of vertical displacements, respectively, for monuments on the downstream edge of the crest, the upstream edge of the crest, and the spillway training walls.

Vertical displacements of all monuments since the previous survey (10/04 to 11/05) are less than 0.01 feet.

4.0 SIGNIFICANT AND NOTEWORTHY SEISMICITY

Noteworthy earthquakes, defined as having approximate magnitudes less than 5.0 (ML) (the approximate District threshold for initiating dam inspections) occurred at 5 locations in the San Francisco Bay Area in the vicinity of the dam during the reporting period from August 2004 through June 2006 (Figure 18) with the following date, magnitude, distance and direction from Anderson Dam:

1. M_L 3.9 on October 25, 2004, 14 miles southeast.
2. M_L 4.4 on November 24, 2004, 45 miles southeast.
3. M_L 4.4 on February 5, 2005, 18 miles northeast.
4. M_L 4.3 on April 1, 2006, 54 miles southeast.
5. M_L 4.7 on June 15, 2006, 9 miles southeast

Figure 18 suggests that the April 1 earthquake occurred on the San Andreas fault and the June 15 earthquake most likely occurred on an unnamed splay fault situated directly east of, and possibly related to, faulting of a postulated pull-apart basin created by a right-stepping bend in the Calaveras fault. The June 15 event was assigned an initial magnitude of 4.7, which the U.S.G.S. later downgraded to magnitude (MW) 4.4.

For the June 15, 2006 event, a post-earthquake inspection of Anderson Dam was completed by staff (S. Wallis) due to concern that the event may have adversely impacted dam safety. The earthquake was below the threshold M 5 earthquake that would have initiated a Post Earthquake Dam Assessment of District dams. For the June 15, 2006 event, the District did perform an informal post-earthquake survey which revealed no damage. Please refer to Section 6.1 Other District Inspections for a brief summary of the activities of the June 15 inspection.

5.0 ACCELEROMETERS

There are 6 accelerometers at the site (5 on the dam, and one on the left abutment knob) which are owned, maintained and monitored by USGS. As mentioned above, a noteworthy earthquake with magnitude 4.4 occurred on June 15, 2006, east of Coyote Dam, about 14 miles southwest of Anderson Dam. The U.S.G.S. has named it the “June 15, 2006 San Martin” earthquake. Acceleration data from the U.S.G.S. accelerometers located on the crest and downstream face of Leroy Anderson Dam due to the San Martin earthquake are summarized below.

Table 5 USGS Acceleration Data from June 15, 2006 San Martin Earthquake

USGS National-Strong Motion Program
Preliminary Corrected Peak Ground Acceleration and Velocity and Pseudo-Spectral Acceleration Values for June 15, 2006, San Martin, California Earthquake (posted 06/23/2006)

State: Location	Owner	Lat	Lon	Dist	Az	Orient	PGA		PGV	PSA at:		
		deg	deg	km	deg	deg	cm/s/s	"g"	cm/s	0.3 s	1.0 s	3.0 s
CA: Anderson Dam	USGS	37.166	-121.63	14.2	300							
Toe						333	-5.7	-0.006	0.217	1.26	0.267	0.0252
Toe						UP	6.5	0.007	0.184	0.73	0.268	0.0271
Toe						63	4.3	0.004	0.368	1.23	0.382	0.0816
Mid-dam, center						333	-7.2	-0.007	-0.244	1.63	0.255	0.0323
Mid-dam, center						63	6.8	0.007	0.558	1.18	0.439	0.0841
Mid-dam, right						63	-5.2	-0.005	0.472	0.96	0.425	0.0856
Right crest						333	8.0	0.008	-0.494	2.69	0.367	0.0341
Right crest						UP	-6.8	-0.007	-0.325	1.83	0.274	0.0241
Right crest						63	-11.1	-0.011	-0.636	3.40	0.557	0.0939
Center crest						333	-7.3	-0.007	-0.454	1.98	0.370	0.0328
Center crest						UP	-6.4	-0.007	-0.385	2.30	0.284	0.0283
Center crest						63	-12.5	-0.013	-0.772	4.39	0.608	0.0979

1) earthquake specifics Mw 4.4, 06/15/2006, 12:24 UTC, 06/15/2006, 05:24 AM PDT, 37.102 N, 121.492 W, 3.1 km depth, Regional Network ID# nc51171759

2) reported by email from USGS Seismologist Christopher Stephens on 11/22/06

3) gray shade show highest recorded accelerations

As noted by gray shading in Table 5, the highest accelerations ranged between 0.007 and 0.013 g, and occurred at the right crest and center crest of the dam.

6.0 VISUAL INSPECTIONS AND MAINTENANCE ISSUES

The following significant inspections were performed during the period of this report include:

1. A March 23, 2005, spring inspection of Anderson Dam and appurtenant facilities by DSOD field engineers Aspet Ordoubigian and Param Dhillon, with several District employees (R. Volpe, J. Aguilera, M. Mooers, J. Nelson, and J. Chiar).

2. An August 8, 2005, annual FERC inspection by FERC engineer Sam Lee, with several District employees (R. Volpe, D. Hook, S. Wallis, J. Aguilera, W. Baker, L. Wong., H. Haase, S. Meyer, T. Pieracci, and J. Nelson).

3. A November 9, 2005, winter inspection of Anderson Dam and appurtenant facilities by DSOD field engineer Aspet Ordoubigian, with several District employees (R. Volpe, D. Hook, J. Aguilera, M. Mooers, S. Wallis, and J. Nelson).

4. An August 31, 2006, fall inspection of Anderson Dam and appurtenant facilities by DSOD field engineer Aspet Ordoubigian, with several District employees (M. Mooers, S. Wallis, and J. Nelson).

6.1 Other District Inspections:

This additional safety inspection by District staff focused on maintenance and monitoring issues.

- April 12, 2006 site inspection to observe reservoir spilling by J. Nelson. According to reservoir water level data, the reservoir spilled from April 6, 2006 through April 13, 2006. The following photographs document spill flow through the spillway (photo 1), spillway terminus (photo 2), and terminus of rock lined channel (photo 3), which produces a spectacular waterfalls.

Photo 1. Spillway with Reservoir Spill (taken on April 12, 2006), view to the east-northeast

Photo 2. Spillway Terminus with Reservoir Spill (taken on April 12, 2006), view to the north-northeast

Photo 3. Rock Channel Terminus with Waterfall (taken on April 12, 2006), view to the northeast

- June 15, 2006 post-earthquake inspection of Leroy Anderson Dam by staff (S. Wallis) due to concern that the June 15, 2006 4.7 earthquake adversely impacted dam safety. The earthquake was below the threshold M 5 earthquake that would have initiated a Post Earthquake Dam Assessment of District dams. Nevertheless, since the epicenter for this event was located only 9 miles SE of the dam, and following discussions with FERC, Stan Wallis of our IPU Dam Safety Section, the manager of the District's Dam Maintenance Program, met with Bart O'Keeffe, FERC Inspector, at the site about 10:00 AM on the morning of 6-15-06. They proceeded to inspect Anderson and Coyote Dam together. No earthquake related conditions were observed during the inspection of Anderson Dam.

7.0 SURVEILLANCE PROGRAM

The District will continue with the current operating procedures and scheduled surveillance plans. Piezometers will be read monthly, crest and spillway training wall monuments will be surveyed annually, and spillway underdrain flows will be measured at the two weirs at least monthly. In addition, site inspections and monument surveys will be conducted after a significant earthquake or other potentially disruptive activity. The instruments are in good working order, so we do not anticipate replacement or repair work in 2005. A significant upgrade in instrumentation is planned at the dam in calendar year 2006.

8.0 OTHER INFORMATION

8.1 New Instrumentation

The District undertook Phase 1 of the Dam Instrumentation Project (DIP) in 2006 which covers four of its dams, one of which is Leroy Anderson Dam. Prior to initiating the DIP construction the District obtained DSOD approval to complete the work. The DIP consists of construction and detailed field and laboratory studies to accomplish the following:

1) drill exploratory borings at various locations throughout the dam in order to obtain both disturbed and undisturbed samples of the various materials used to build the dam;
2) perform insitu testing to determine the engineering properties of the various zones within the dam; and
3) install geotechnical instruments, including vibrating wire piezometers and in-place inclinometers, in various borings and locations throughout the dam for long-term monitoring.

By December 31, 2006, the District had installed 31 new vibrating wire gauge piezometers and installed one in-place inclinometer casing within Anderson Dam. Future annual safety reports to be prepared by the District will summarize the collected instrumentation data. The District will also prepare and submit to DSOD a detailed report summarizing the new field and laboratory data.

8.2 Future Engineering Analyses

FERC has requested the District to investigate the presence of the upstream and downstream transition zones in the dam. The transition zones are located between the impervious core and the upstream and downstream rockfill zones and should consist of intermediate-graded materials between these two units.

In order to study the presence of this transition zone issue within the dam, the District has initiated two phases of investigation. The first phase involves the present DIP investigation where samples of the transition zone will be sampled and analyzed. The second phase involves more detailed analyses during the upcoming Seismic Stability Evaluation (SSE) of the Phase 1 dams. In addition to addressing the transition zone issue, the SSE will also complete a full seismotectonic study of regional and local seismic setting and the static and dynamic stability analyses of the dam. These studies are scheduled for completion in December 2007. DSOD will receive copies of all data being generated for the DIP and SSE studies.

9.0 CONCLUSIONS

We conclude that Anderson Dam shows a normal response to its environment, aging process, and external events. The District will continue with the current monitoring program and safety inspections and will keep DSOD informed of any significant changes pertaining to the surveillance or performance of Leroy Anderson Dam.

Our review of the monitoring data presented herein does not indicate unusual or abnormal changes in the monitoring data during the subject reporting period. Our review of the surveillance data, and our periodic safety inspections, indicate that Anderson Dam appears to show normal responses to the environment, aging process, and external events.

As noted in the 2004 report (Nelson and Mooers, 2004), two anomalous spikes in the data for PPA-2 (Figure 4) were attributed to errors introduced by an inexperienced field technician. No data spikes were observed from PPA-2 during the current monitoring period. Proper field training of the field technician for operating the readout box for the pneumatic piezometers appears to have resolved this issue. We will continue to monitor this issue and keep DSOD appraised.

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TABLE 1
Recent Piezometric Data
Leroy Anderson Dam

Date		Reservoir Level (ft)	PPA-1	PPA-2	OW-1	Monthly* Rainfall (in)
			Piezometric Surface Elevation (ft)			
1/18/05	2005.047	600.85	565.90	495.32	406.26	4.21
2/21/05	2005.138	613.47	566.04	495.69	406.57	4.95
3/18/05	2005.213	625.91	566.11	497.91	406.41	3.82
4/22/05	2005.308	626.35	568.35	497.95	406.40	1.69
5/26/05	2005.402	626.02	572.85	500.22	406.42	1.73
6/9/05	2005.439	624.04	572.95	500.24	406.40	0.24
7/14/05	2005.536	618.82	575.26	500.35	406.34	0.00
8/22/05	2005.641	615.04	577.57	502.53	403.88	0.00
9/21/05	2005.721	611.92	577.50	502.55	403.74	0.08
10/17/05	2005.794	609.90	577.47	502.57	403.84	0.24
11/11/05	2005.861	612.33	575.35	502.55	405.55	0.59
12/16/05	2005.958	609.52	575.35	502.55	405.98	8.66
1/8/06	2006.019	613.71	575.32	502.57	406.15	2.64
2/10/06	2006.108	613.01	575.35	502.60	406.05	1.73
3/20/06	2006.219	624.20	577.47	502.66	406.20	5.55
4/17/06	2006.294	627.90	577.54	502.55	406.17	3.90
5/15/06	2006.372	627.64	NR	NR	NR	0.59
6/19/06	2006.466	624.16	579.92	504.95	406.51	0.00
7/15/06	2006.538	619.73	NR	NR	NR	0.00
8/15/06	2006.622	613.65	NR	NR	NR	0.00
9/26/06	2006.735	606.13	579.99	505.95	406.30	0.00
10/19/06	2006.799	604.85	570.98	500.63	406.17	0.04
11/8/06	2006.853	604.98	579.76	502.48	406.35	see below
11/16/06	2006.874	605.36	579.74	495.55	406.28	0.98
11/28/06	2006.907	606.64	NR	508.02	NR	see above
12/20/06	2006.969	606.84	577.52	505.00	406.19	2.20

Notes:
1) Piezometer data is Piezometric Surface Elevation (PSE in feet)
2) PSE = pressure head (ft) + elevation head (ft)
3) basis of elevations is NAVD 1988 - values in this table are 2.8 feet higher
than NGVD 1929
4) NR = no readings collected
5) OW-1 installed 8/5/03

TABLE 2

Recent Weir Discharge Data Spillway Underdrains

Leroy Anderson Dam

Date	Decimal year	Reservoir Level (ft)	Underdrain Weir No. 1	flow (gpm) Weir No. 2	Total flow (gpm)
01/18/05	2005.047	600.85	20.70	4.94	25.64
02/21/05	2005.138	613.47	88.90	31.90	120.80
03/18/05	2005.213	625.91	178.00	111.00	289.00
04/22/05	2005.308	626.35	208.00	168.00	376.00
05/26/05	2005.402	626.02	220.00	198.00	418.00
06/09/05	2005.439	624.04	231.00	158.00	389.00
07/14/05	2005.536	618.82	208.00	76.30	284.30
08/22/05	2005.641	615.04	178.00	54.30	232.30
09/21/05	2005.721	611.92	158.00	34.60	192.60
10/17/05	2005.794	609.90	142.00	16.60	158.60
11/11/05	2005.861	612.33	158.00	26.00	184.00
12/16/05	2005.958	609.52	134.00	14.80	148.80
01/18/06	2006.047	613.71	198.00	29.20	227.20
02/10/06	2006.108	613.01	158.00	26.00	184.00
03/20/06	2006.219	624.20	220.00	118.00	338.00
04/17/06	2006.294	627.90	265.00	210.00	475.00
05/15/06	2006.372	627.64	NR	NR	NR
06/19/06	2006.466	624.16	242.00	150.00	392.00
07/15/06	2006.538	619.73	NR	NR	NR
08/15/06	2006.622	613.65	NR	NR	NR
09/29/06	2006.743	606.22	103.00	8.08	111.08
10/19/06	2006.799	604.85	NR	NR	NR
11/08/06	2006.853	604.98	NR	NR	NR
11/16/06	2006.874	605.36	96.10	9.43	105.53
12/20/06	2006.969	606.84	103.00	9.43	112.43

Notes: 1) Weir No. 1 collects flow from the central portion of spillway

2) Weir No. 2 collects flow from the left side of the spillway

TABLE 3
Vertical and Local Transverse Data - Crest and Abutment Monuments
Leroy Anderson Dam

Date		Cumulative Monument Vertical Displacement (feet) (since 1988)															
		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
07/19/88		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10/24/1989		0.02	-0.02	-0.01	-0.12	-0.05	-0.13	-0.06	-0.04	-0.14	-0.02	-0.04	0.00	0.02	0.03	0.05	0.03
10/28/1990		0.02	-0.16	-0.14	-0.27	-0.19	-0.30	-0.22	-0.19	-0.29	-0.16	-0.13	-0.09	-0.06	-0.04	-0.03	-0.04
06/07/1991		0.02	-0.05	-0.06	-0.18	-0.13	-0.23	-0.17	-0.13	-0.24	-0.10	-0.10	-0.04	0.00	0.01	0.03	0.00
01/08/1992		-0.02	-0.09	-0.10	-0.24	-0.17	-0.27	-0.23	-0.17	-0.29	-0.14	-0.12	-0.08	-0.04	-0.03	0.01	-0.01
01/27/1993		0.02	-0.06	-0.08	-0.24	-0.18	-0.29	-0.23	-0.22	-0.35	-0.21	-0.19	-0.12	-0.08	-0.07	-0.07	-0.09
11/01/1994		0.02	-0.07	-0.06	-0.23	-0.17	-0.28	-0.24	-0.21	-0.34	-0.19	-0.15	-0.10	-0.05	-0.03	-0.02	-0.04
12/05/1994		0.02	-0.07	-0.07	-0.24	-0.18	-0.30	-0.25	-0.19	-0.31	-0.15	-0.14	-0.07	-0.03	-0.01	0.01	-0.02
01/04/1996		-0.05	-0.12	-0.11	-0.25	-0.19	-0.29	-0.25	-0.19	-0.31	-0.14	-0.13	-0.07	-0.04	-0.03	-0.02	-0.01
05/22/1996		0.01	-0.06	-0.04	-0.20	-0.14	-0.26	-0.24	-0.18	-0.30	-0.13	-0.12	-0.05	-0.01	-0.01	0.01	-0.01
01/29/1997		0.03	-0.06	-0.05	-0.23	-0.17	-0.30	-0.25	-0.20	-0.32	-0.16	-0.13	-0.07	-0.02	-0.01	0.01	-0.01
12/11/1998		0.02	-0.07	-0.06	-0.24	-0.18	-0.31	-0.27	-0.21	-0.34	-0.16	-0.14	-0.07	-0.02	-0.01	0.01	-0.01
12/03/1999		0.01	-0.07	-0.07	-0.25	-0.19	-0.31	-0.27	-0.21	-0.34	-0.16	-0.14	-0.08	-0.03	-0.01	0.01	0.00
11/28/2000		0.02	-0.07	-0.07	-0.26	-0.19	-0.33	-0.28	-0.23	-0.35	-0.18	-0.15	-0.08	-0.03	-0.02	0.00	0.00
10/18/2001		0.01	-0.07	-0.08	-0.26	-0.20	-0.33	-0.29	-0.23	-0.36	-0.18	-0.15	-0.08	-0.03	-0.02	0.01	-0.01
10/15/2002		0.01	-0.07	-0.09	-0.27	-0.21	-0.34	-0.30	-0.23	-0.36	-0.19	-0.15	-0.09	-0.02	-0.01	0.01	0.00
11/04/2003		0.01	-0.08	-0.09	-0.28	-0.22	-0.36	-0.31	-0.24	-0.37	-0.20	-0.16	-0.08	-0.03	-0.01	0.01	NR
10/15/2004	(o)	0.05	-0.04	-0.05	-0.25	-0.18	-0.32	-0.27	-0.21	-0.33	-0.15	-0.12	-0.04	0.01	0.03	0.06	NR
10/15/2004	(n)	0.05	-0.04	-0.05	-0.25	-0.18	-0.32	-0.27	-0.21	-0.33	-0.15	-0.12	-0.04	0.01	0.03	0.06	NR
11/01/2005		0.06	-0.02	-0.03	-0.22	-0.16	-0.30	-0.26	-0.20	-0.32	-0.14	-0.10	-0.03	0.02	0.04	0.06	NR
10/31/2006		0.06	-0.02	-0.03	-0.22	-0.16	-0.31	-0.26	-0.19	-0.32	-0.14	-0.10	-0.03	0.02	0.04	0.06	NR
change in disp.		-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NR
10/04 to 11/05			Average change since last survey in ft =					0.00	or 0.12"								

TABLE 3
Vertical and Local Transverse Data - Crest and Abutment Monuments
Leroy Anderson Dam

Date		Cumulative Dam Crest Monument Local Transverse Displacement (feet) (since 1988)															
		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
07/19/88		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10/24/1989		0.00	-0.04	0.03	-0.04	0.04	-0.03	0.03	-0.02	-0.07	0.03	-0.02	0.02	0.00	0.00	0.00	0.00
10/28/1990		0.00	-0.02	0.03	-0.04	0.04	-0.01	0.06	0.02	-0.04	0.06	-0.01	0.04	0.00	-0.01	0.00	0.00
06/07/1991		0.00	-0.01	0.07	-0.03	0.06	-0.03	0.04	-0.02	-0.04	0.05	0.00	0.04	0.01	-0.01	0.00	-0.02
01/08/1992		0.00	-0.03	0.05	-0.02	0.07	-0.01	0.06	-0.01	-0.06	0.06	-0.01	0.04	0.00	-0.01	0.00	-0.01
01/27/1993		0.00	-0.03	0.05	-0.03	0.06	-0.01	0.05	-0.01	-0.06	0.05	-0.01	0.04	0.00	0.00	0.00	0.00
11/01/1994		0.00	-0.03	0.03	-0.09	0.00	-0.10	0.00	-0.06	-0.11	0.02	-0.03	0.03	0.00	-0.01	0.00	-0.01
12/05/1994		0.00	-0.04	0.03	-0.07	0.02	-0.08	0.01	-0.06	-0.11	0.02	-0.03	0.03	-0.01	-0.01	0.00	0.00
01/04/1996		0.00	-0.05	0.01	-0.12	-0.03	-0.13	-0.04	-0.10	-0.14	0.01	-0.05	0.04	-0.01	-0.01	0.00	0.00
05/22/1996		0.00	-0.03	0.00	-0.13	-0.05	-0.14	-0.03	-0.11	-0.17	-0.01	-0.06	0.03	-0.01	-0.01	0.00	-0.02
01/29/1997		0.00	-0.05	-0.01	-0.14	-0.06	-0.17	-0.05	-0.12	-0.17	-0.02	-0.06	0.02	-0.01	0.00	0.00	0.00
12/10/1998		0.00	-0.08	-0.06	-0.16	-0.09	-0.18	-0.05	-0.12	-0.18	-0.01	-0.05	0.04	0.00	-0.02	0.00	-0.01
12/03/1999		0.00	-0.05	-0.01	-0.14	-0.06	-0.18	-0.05	-0.13	-0.18	-0.02	-0.06	0.04	-0.01	-0.01	0.00	-0.01
11/28/2000		0.00	-0.04	0.01	-0.13	-0.06	-0.17	-0.05	-0.14	-0.18	-0.02	-0.06	0.04	0.00	-0.02	0.00	0.00
10/18/2001		0.00	-0.04	0.01	-0.12	-0.05	-0.16	-0.04	-0.12	-0.16	0.00	-0.05	0.05	-0.01	-0.02	0.00	-0.01
10/15/2002		0.00	-0.03	0.01	-0.10	-0.03	-0.14	-0.02	-0.11	-0.15	0.01	-0.04	0.06	0.00	-0.01	0.00	-0.03
11/04/2003		0.00	-0.03	0.02	-0.12	-0.02	-0.14	-0.02	-0.11	-0.17	-0.02	-0.06	0.06	-0.02	-0.01	0.00	NR
10/15/2004	(o)	0.00	-0.04	0.02	-0.10	-0.02	-0.15	-0.01	-0.10	-0.17	0.03	-0.04	0.06	0.00	-0.03	0.00	NR
10/15/2004	(n)	0.00	-0.04	0.02	-0.10	-0.02	-0.15	-0.01	-0.10	-0.17	0.03	-0.04	0.06	0.00	-0.03	0.00	NR
11/01/2005		0.00	-0.04	0.00	-0.13	-0.06	-0.18	-0.05	-0.13	-0.19	-0.01	-0.06	0.05	-0.02	-0.01	0.00	NR
10/31/2006		0.00	-0.05	0.00	-0.14	-0.05	-0.19	-0.06	-0.13	-0.20	-0.01	-0.05	0.06	-0.02	-0.03	0.00	NR
change in disp.		0.000	-0.004	0.003	-0.011	0.009	-0.008	-0.006	-0.003	-0.003	-0.001	0.011	0.006	0.002	-0.014	0.00	NR
11/05 to 10/06			Average change since last survey in ft =					0.00	or 0.24"								

Notes:

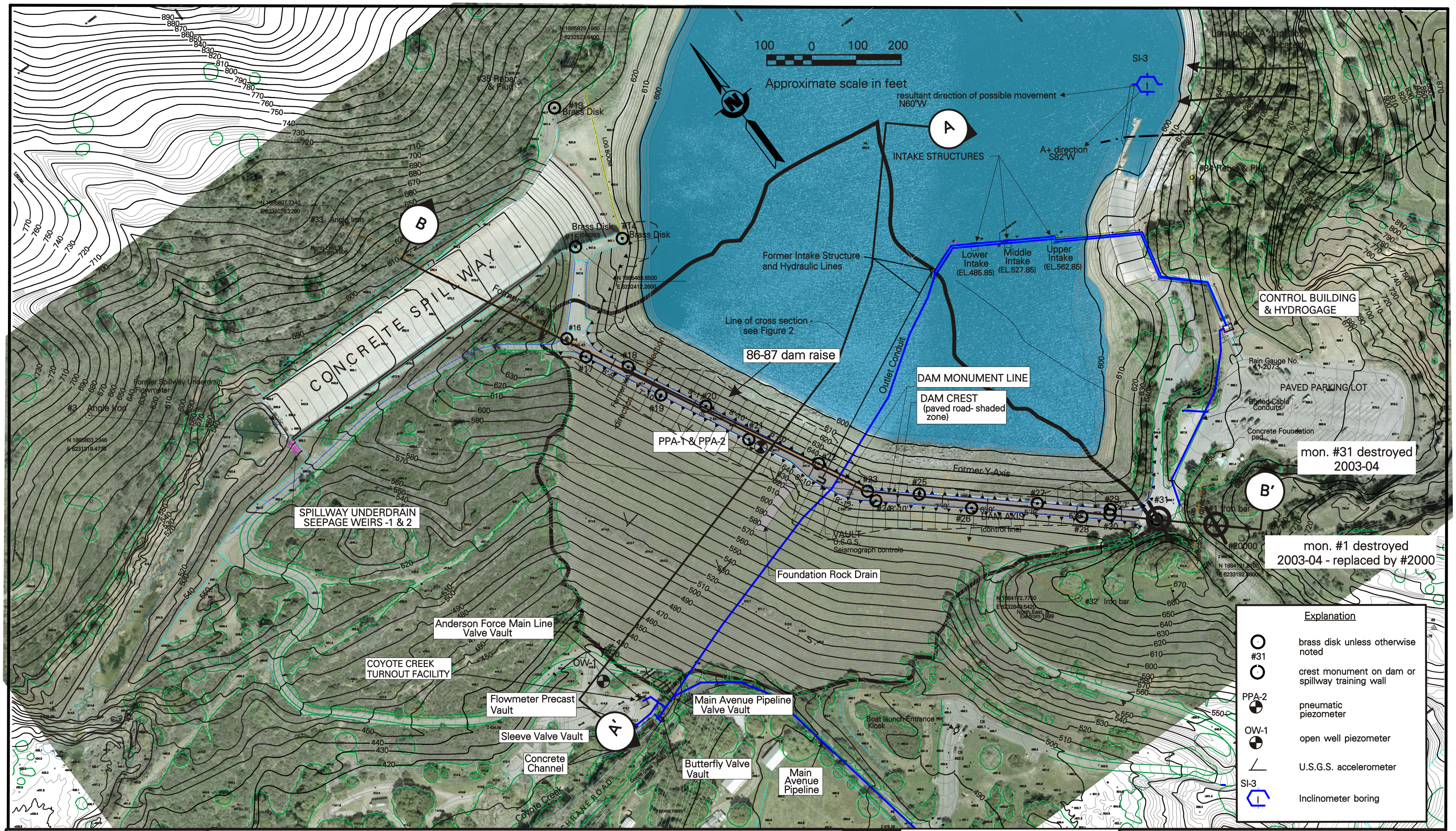
1) Negative transverse displacement signifies downstream movement
2) Positive transverse displacement signifies upstream movement
3) Displacement is net displacement since 1988
4) NR = monument not surveyed (Mon. 31 destroyed)
5) Local Transverse data shown back calculated to 1988 - see text
6) Mon #31 destroyed 2003/04 - see text
7) Mons #16 and 31 are control points and do not show local transverse displacement
8) (o) = old epoch survey; (n) = new epoch survey; see text

TABLE 4
Vertical Displacement Data
Spillway Monuments
Leroy Anderson Dam

Date		Monument Vertical Displacement (feet)		
		13	14	15
10/18/2001		0.03	-0.01	0.00
10/15/2002		NR	-0.01	0.00
11/04/2003		NR	-0.01	0.00
10/15/2004	(o)	NR	0.03	0.04
10/15/2004	(n)	NR	0.03	0.04
11/01/2005		NR	0.05	0.04
10/31/2006		NR	0.05	0.06
change in disp. from 11/05 to 10/06		NR	0.00	0.011

Average change since last survey in ft = 0.01 or 0.12"

Notes:
1) Negative vertical displacement represents settlement
2) Positive vertical displacement represents heave
3) (o) = old epoch survey; (n) = new epoch survey; see text



Reference information and notes:
1) This map is a compilation of aerial mapping, survey field data, and digitized construction maps. Maximum error could be ± one foot vertical and horizontal
2) Grid is based on California Coordinate System, Zone III, NAD 83.
3) Elevations based on N.G.S. Vertical datum, NAVD 88. The DE between NAVD 29 and NGVD 88 is 2.80'
4) Photogrammetric mapping: Transvision, Photo date 12/11/97; base photo is high res. taken April 2001
5) * control point #1 destroyed 2003-04 during boat ramp work and replaced by #20000
6) file W:\geology\dams\annual dam safety report\DSOD\Anderson\2006 report\ANDfig1-06.cdr

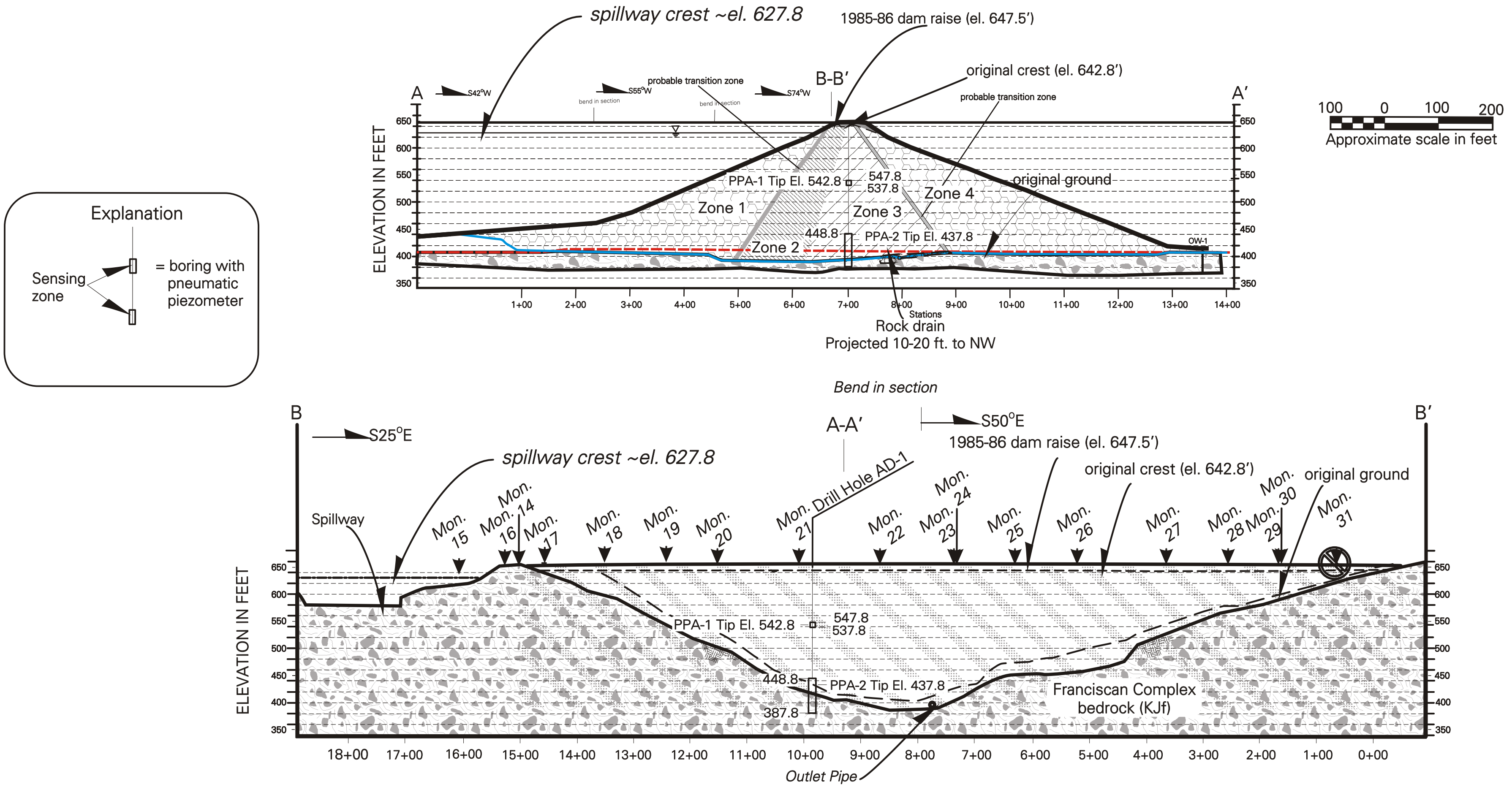
revised 10/21/04

DATE 03/24/03
DESIGN JLN
DRAWN BLS
CHECKED JLN

Santa Clara Valley Water District

Topographic Map
Leroy Anderson Dam
Surveillance Instrumentation

SCALE 1" = 200'
FIGURE 1



File: W:\geology\dams\annual dam safety reports\DSOD\Anderson\2006\andfig2-06.cdr

DATE	12/02/00
DESIGN	JLN
DRAWN	JLN
CHECKED	RLV

Santa Clara Valley Water District

Cross Sections A-A' & B-B'

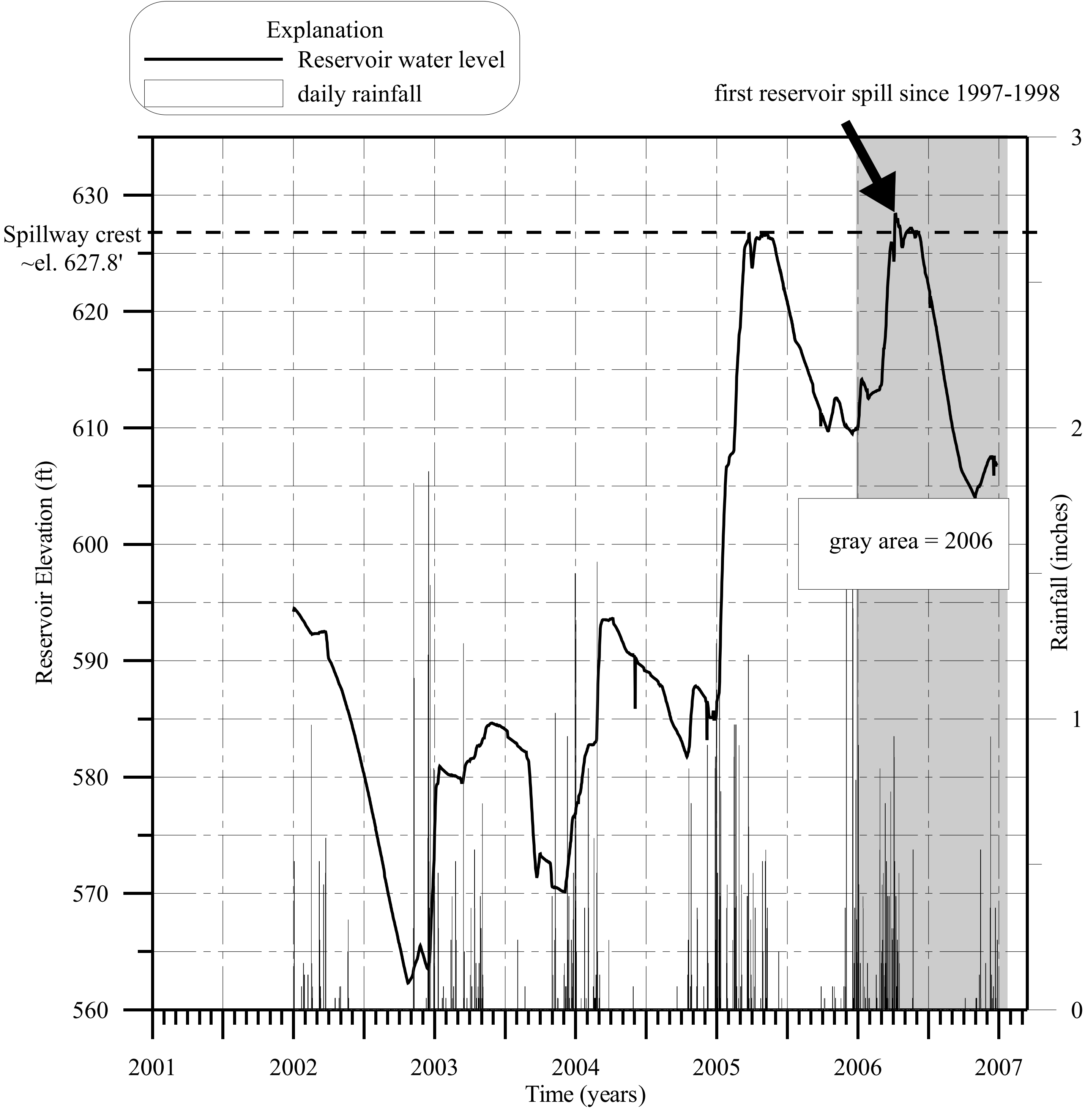
Piezometer Locations

SCALE
1" = 200'

FIGURE
2

LEROY ANDERSON DAM (No. 72-9)

Santa Clara Valley Water District



Notes: 1) basis of elevations is NAVD 1988 - values are 2.8 feet higher than NGVD 1929
2) file W:\geology\dams\annual dam safety reports\DSOD\Anderson\2006\resplot-06

Figure 3. Daily Reservoir Elevation and Rainfall 2002-2006

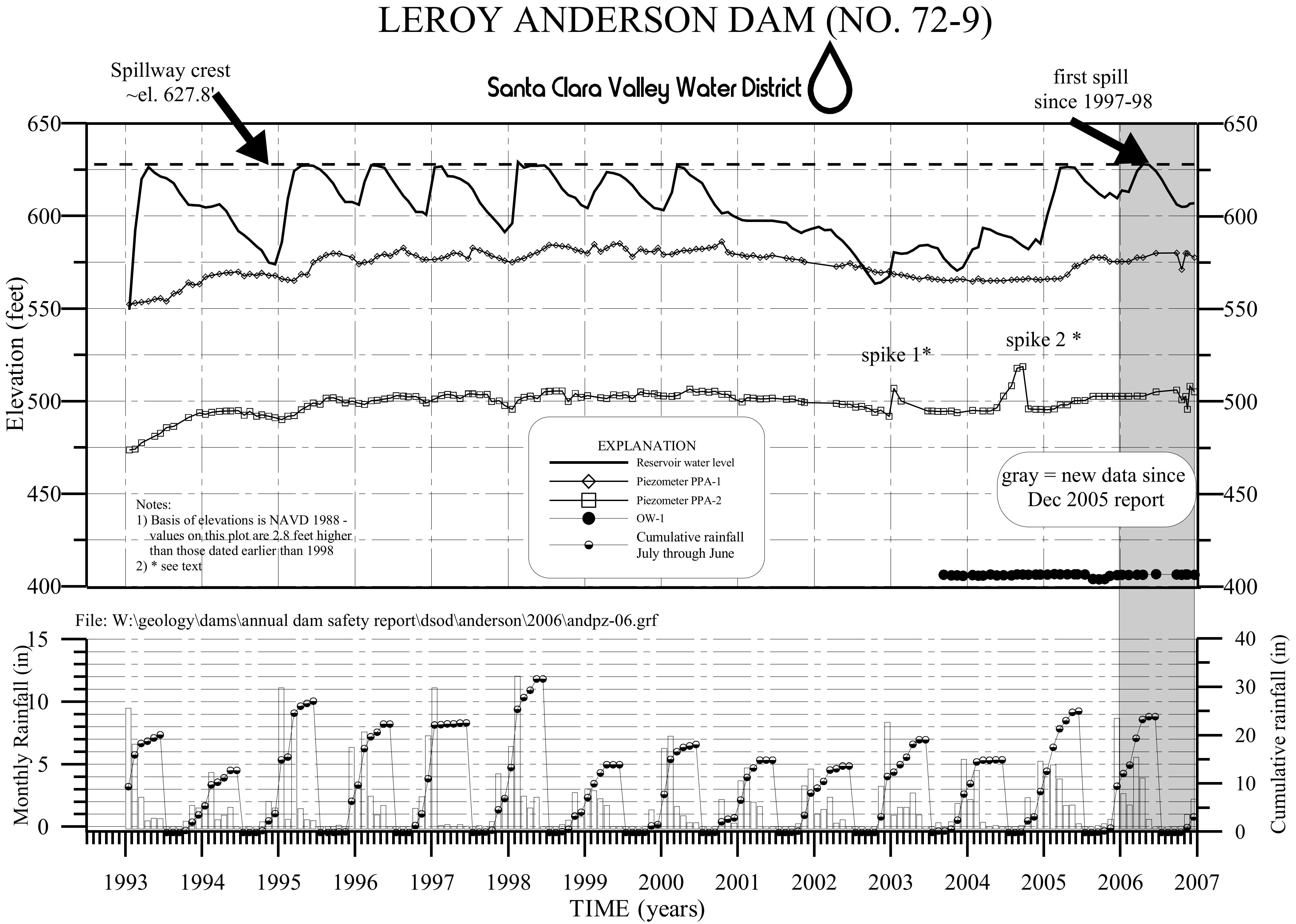


Figure 4. Piezometer Levels - Embankment

LEROY ANDERSON DAM (No. 72-9)

Santa Clara Valley Water District

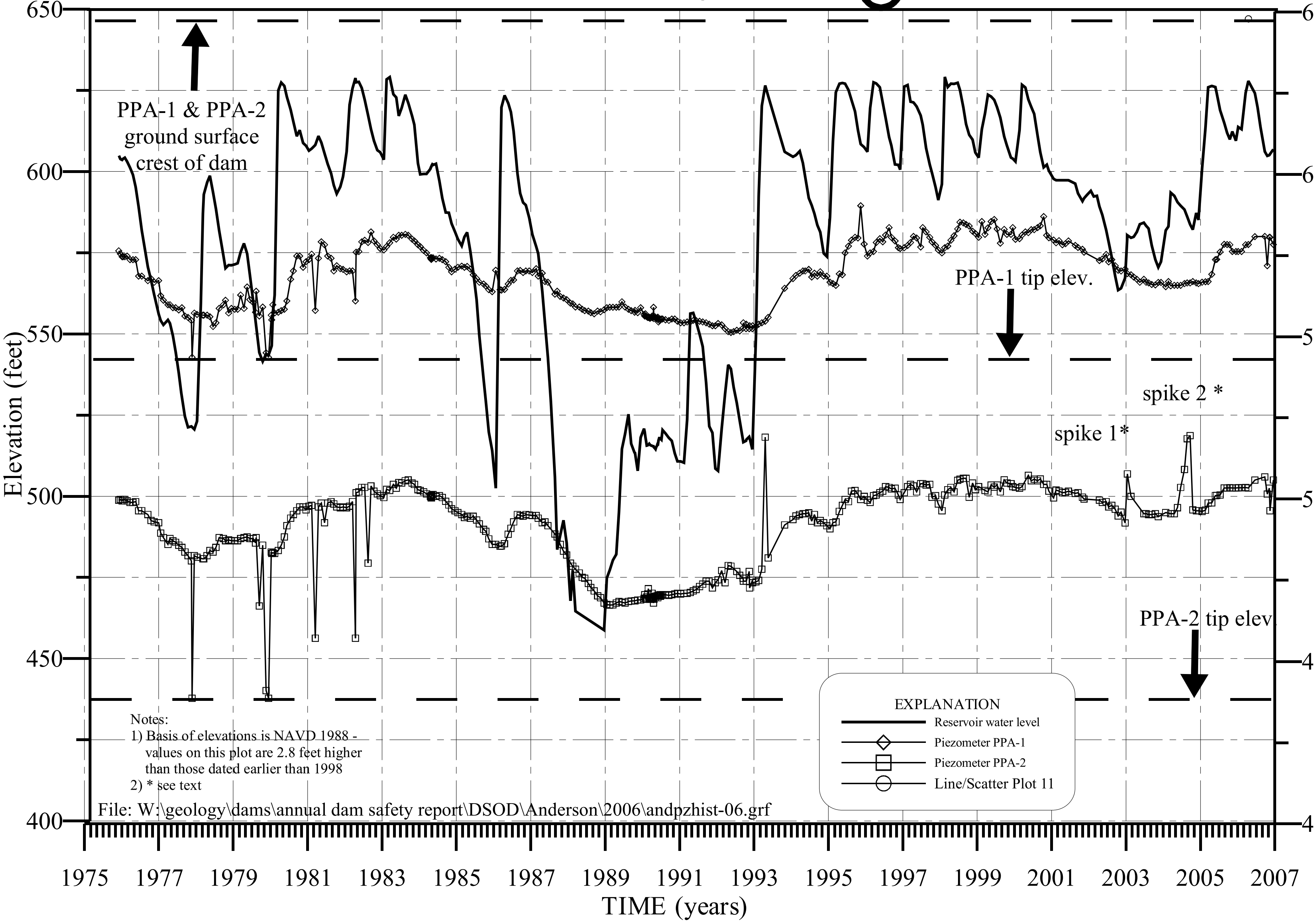


Figure 5. Historic PPA-1 and PPA-2 Piezometer Levels - Embankment

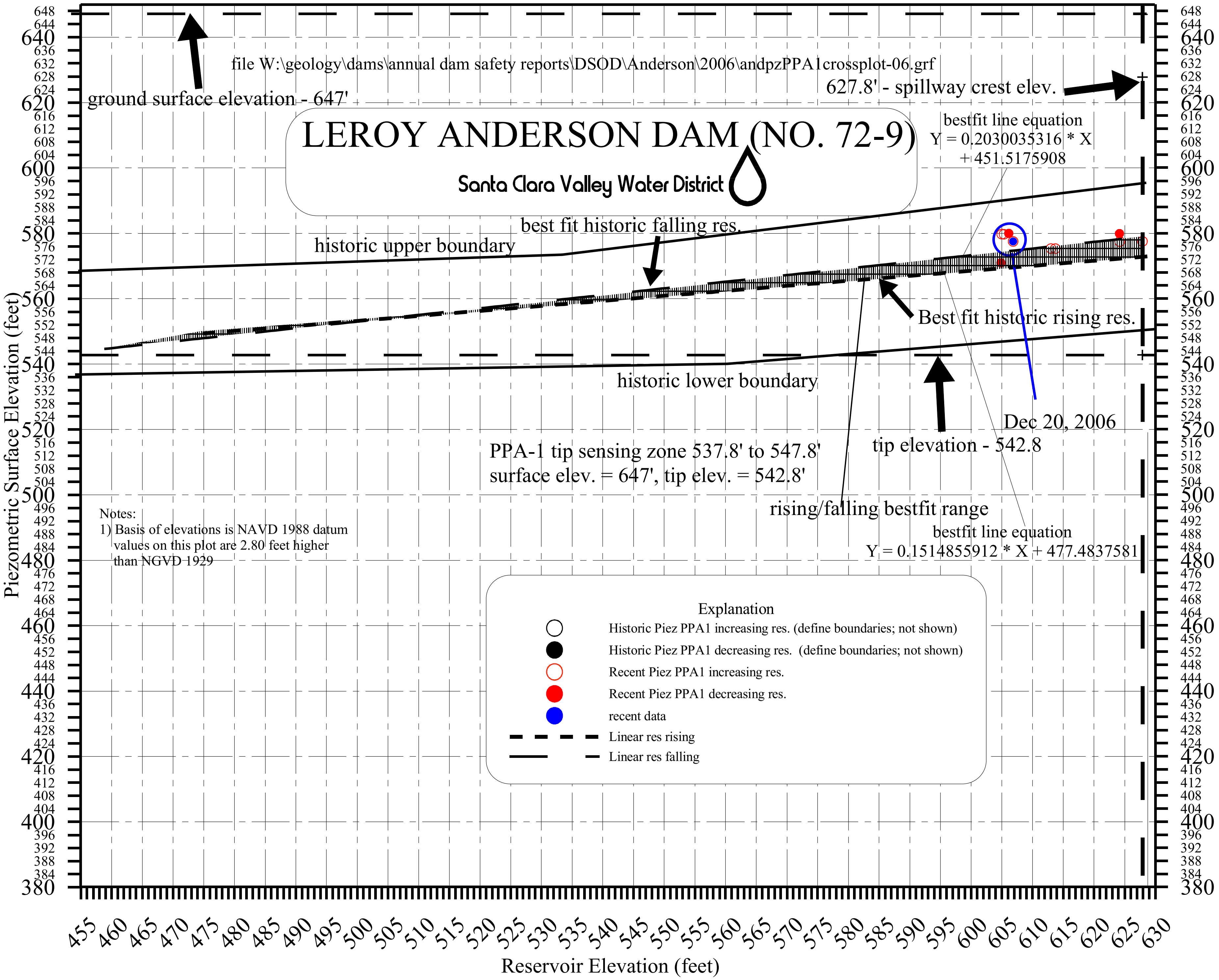


Figure 6. Historic Cross-Plot of Reservoir Elevation vs. PPA1 Piezometer Data

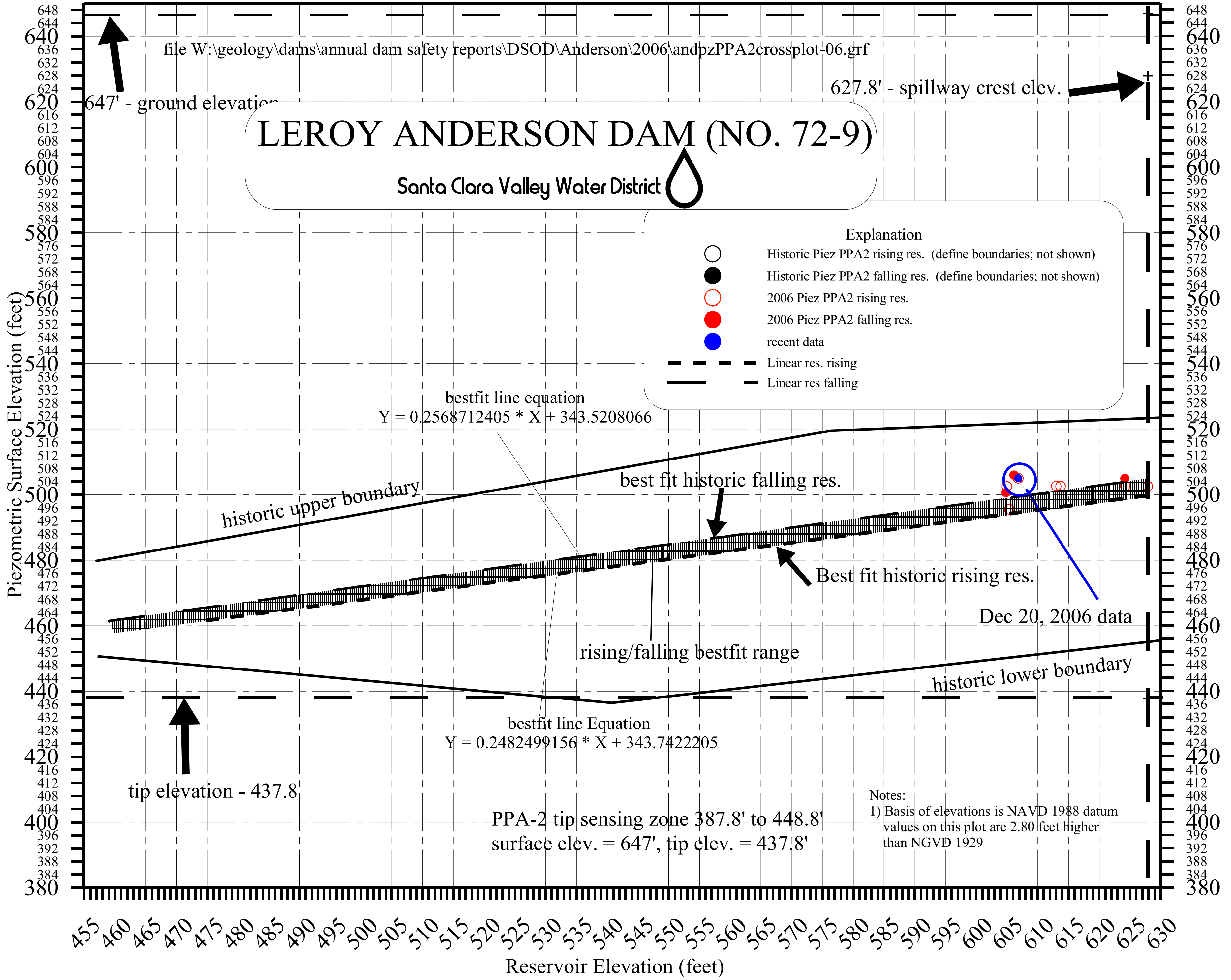


Figure 7. Historic Cross-Plot of Reservoir Elevation vs. PPA2 Piezometer Data

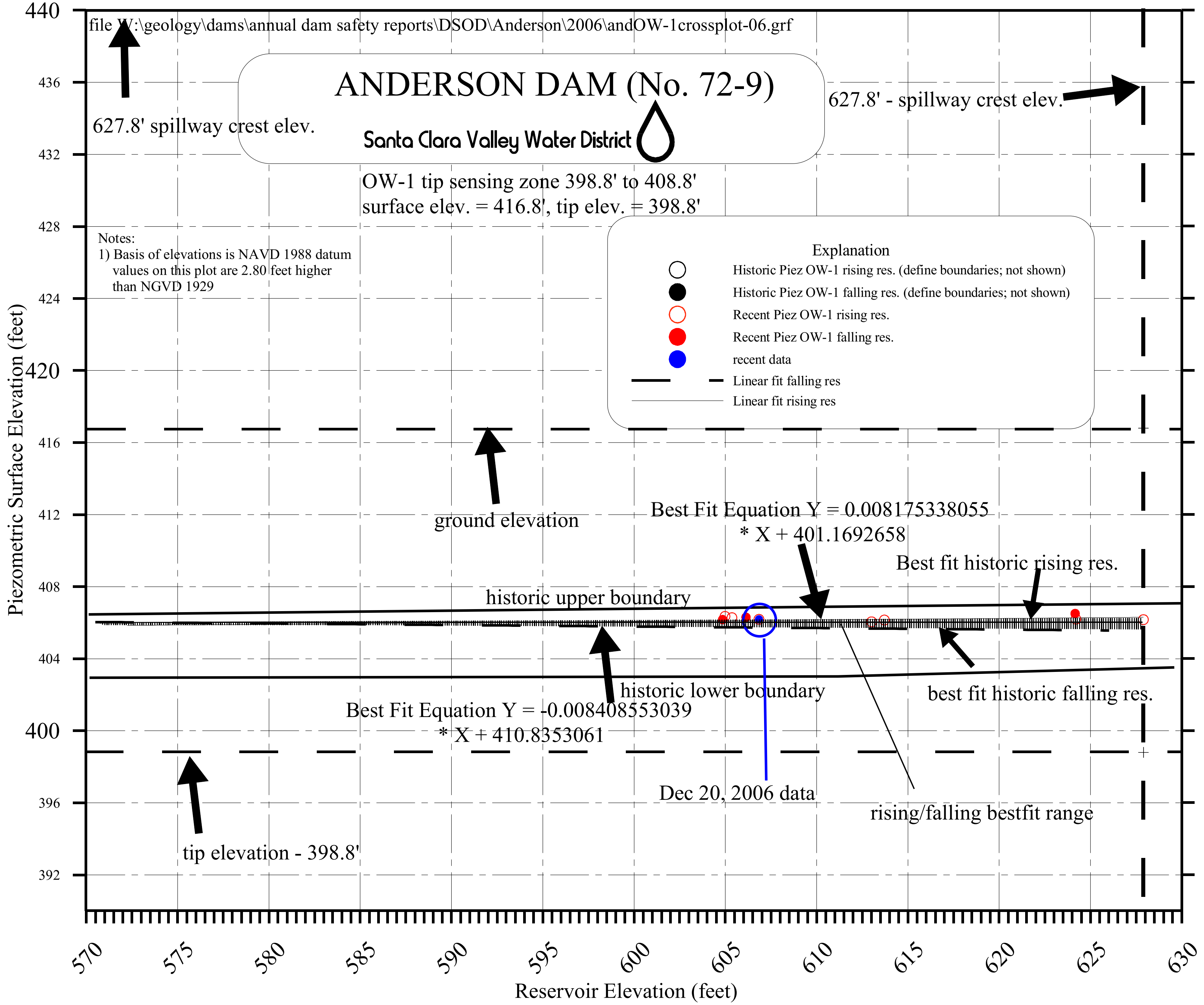
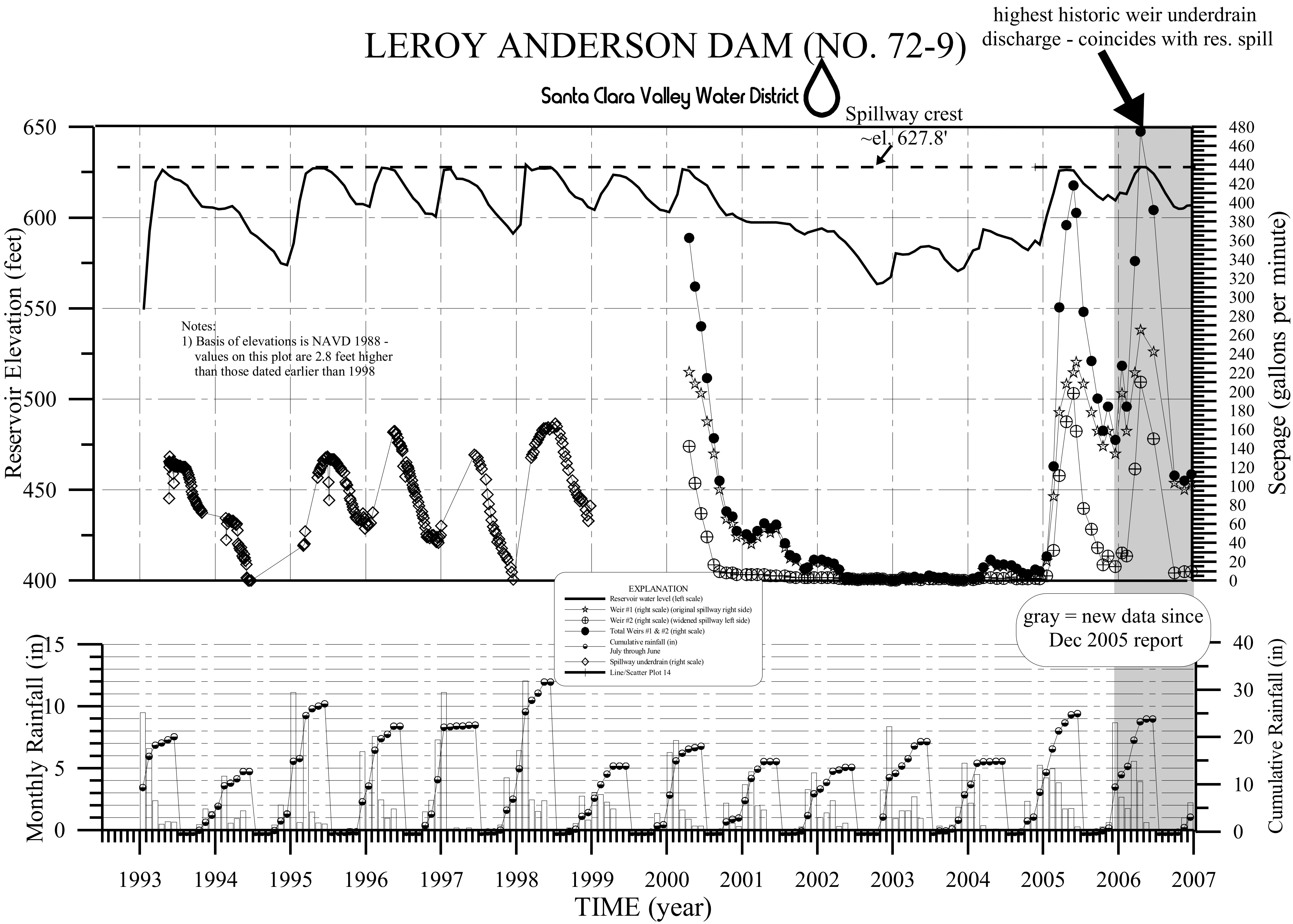


Figure 8. Historic Cross-Plot of Reservoir Elevation vs. OW-1 Piezometer Data



File: W:\geology\dams\annual dam safety report\DSOD\Anderson\2006\andspil-06.grf

Figure 9. Weir Discharge Data - Spillway Underdrains

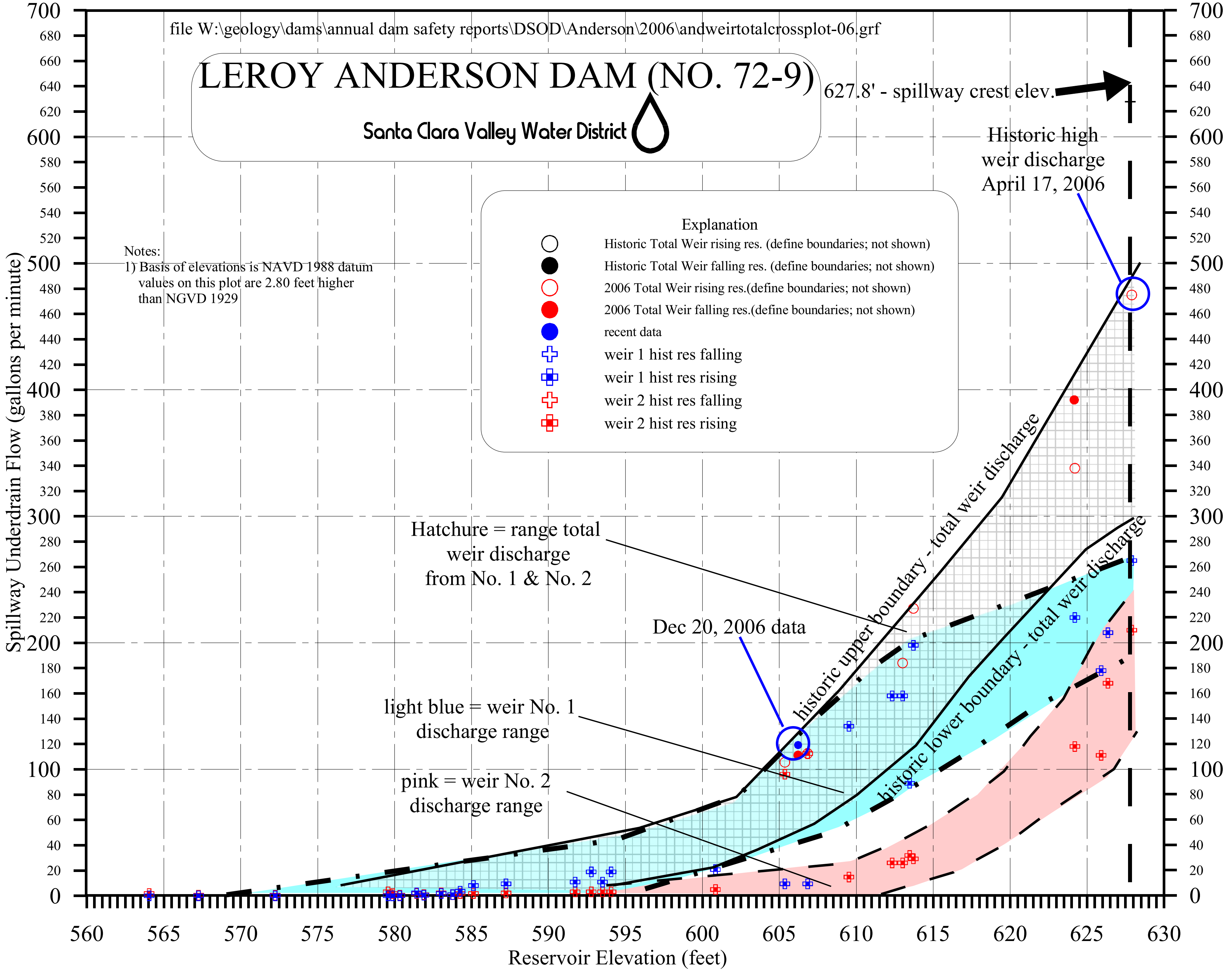


Figure 10. Historic Cross-Plot of Reservoir Elevation vs. Spillway Weir Discharge, gpm

ANDERSON DAM (No. 72-9)

Santa Clara Valley Water District

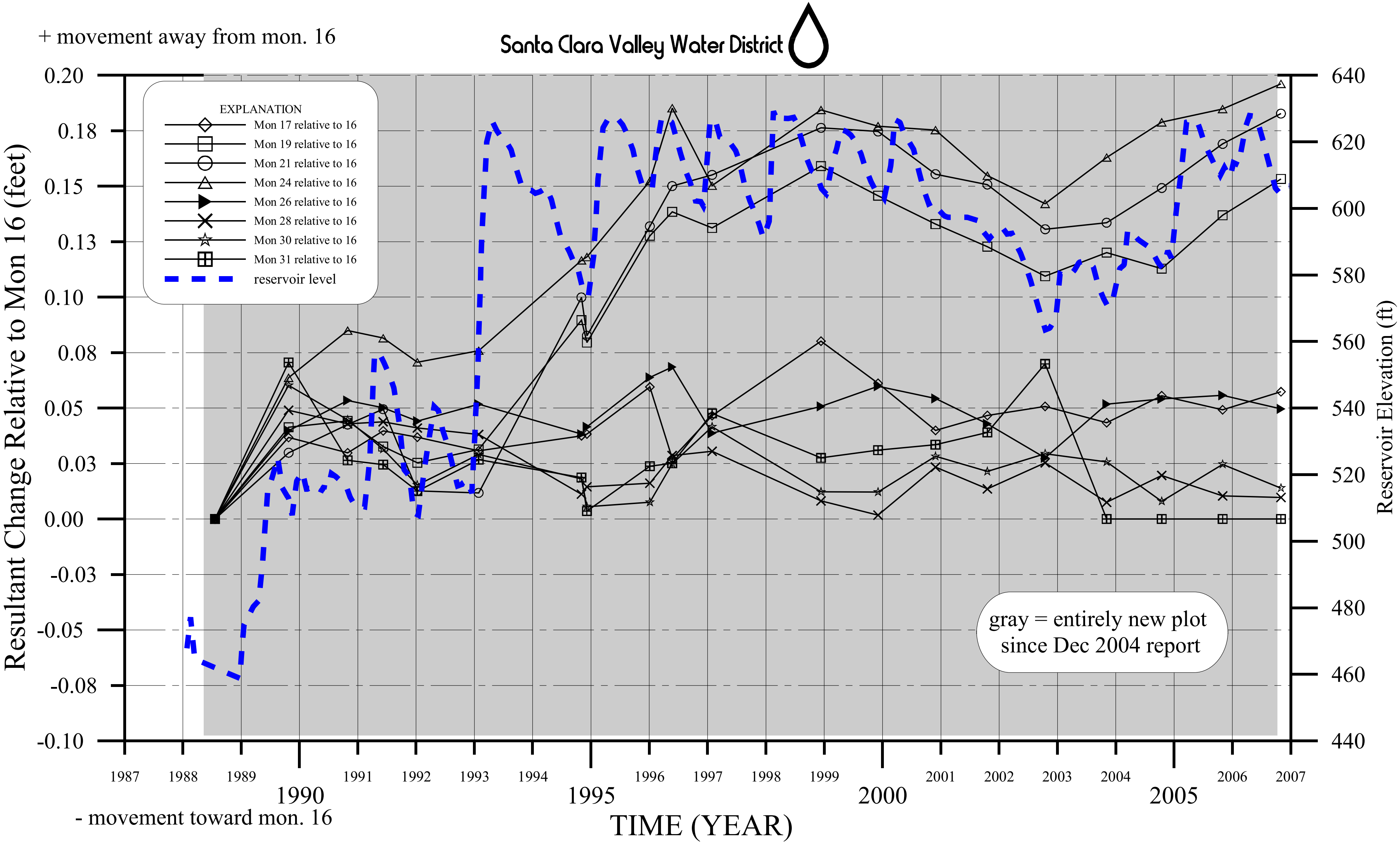


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Figure 11 - Resultant Displacement Relative to Mon 16 - Monuments at Downstream Edge of Crest

ANDERSON DAM (No. 72-9)

Santa Clara Valley Water District

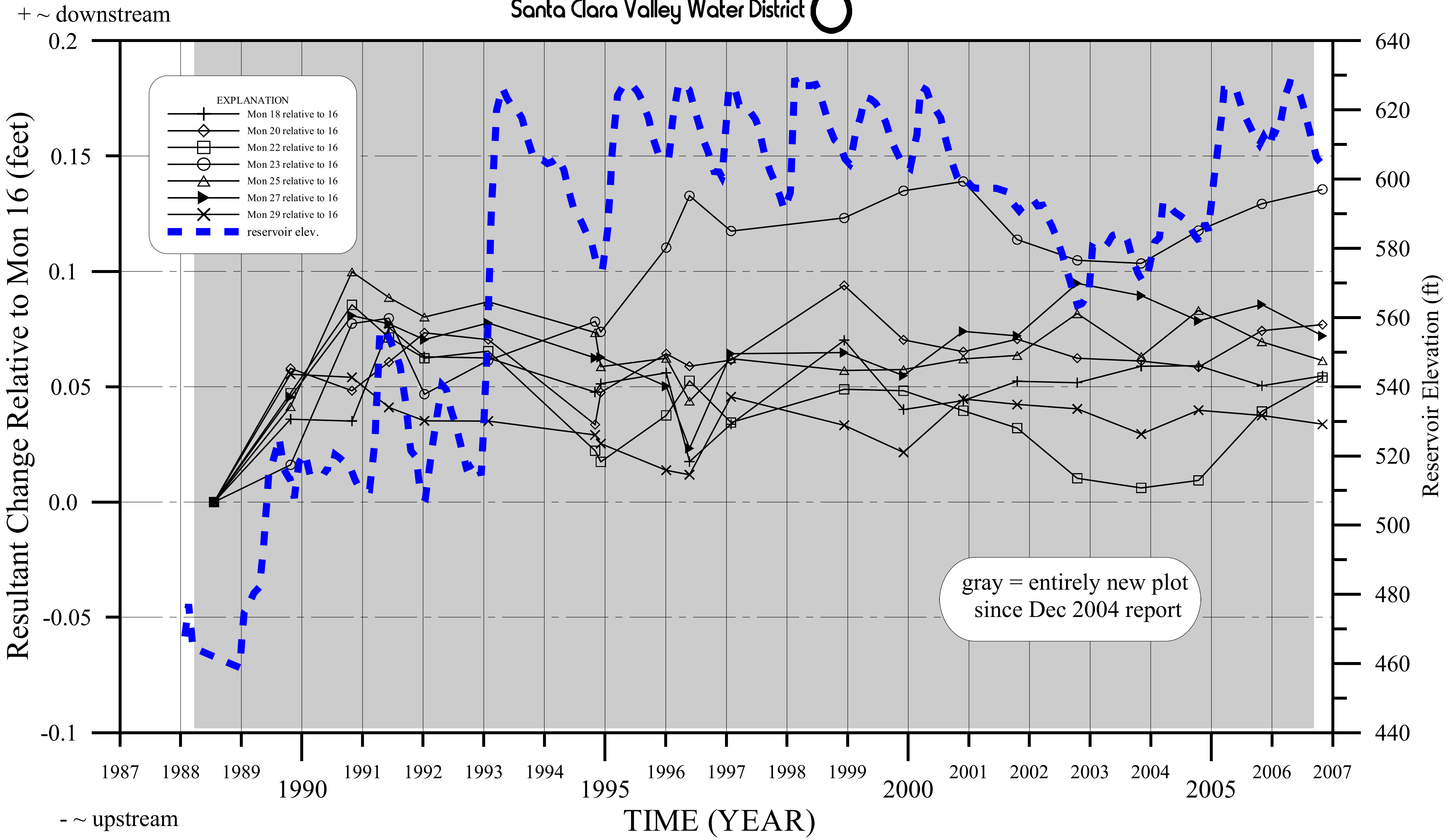

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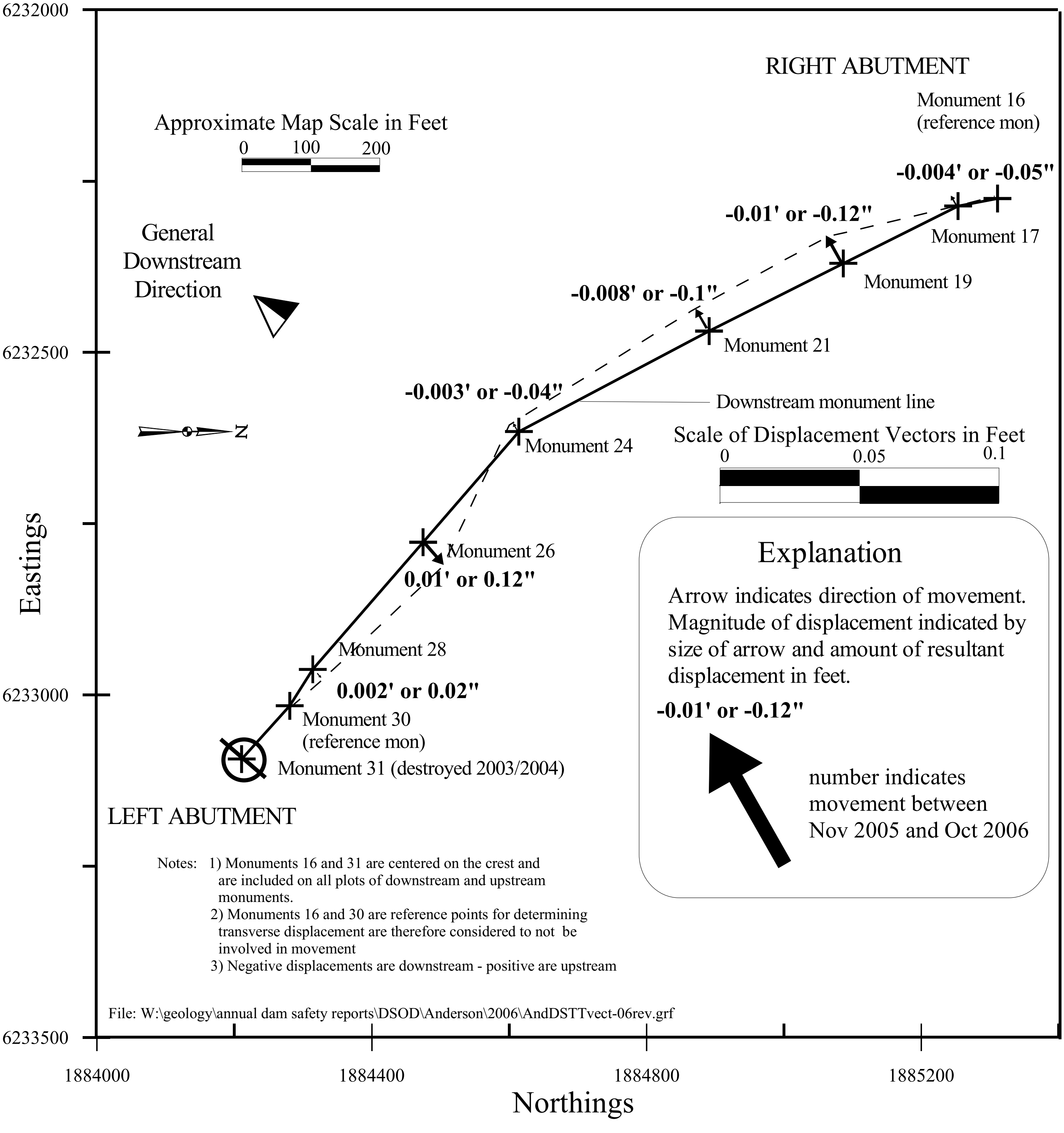
Figure 12 - Resultant Displacement Relative to Mon 16 - Monuments at Upstream Edge of Crest

LEROY ANDERSON DAM (No. 72-9)

Santa Clara Valley Water District



Arrow indicates direction of movement. Magnitude of displacement indicated by size of arrow and amount of resultant displacement in feet.

number indicates movement between Nov 2005 and Oct 2006

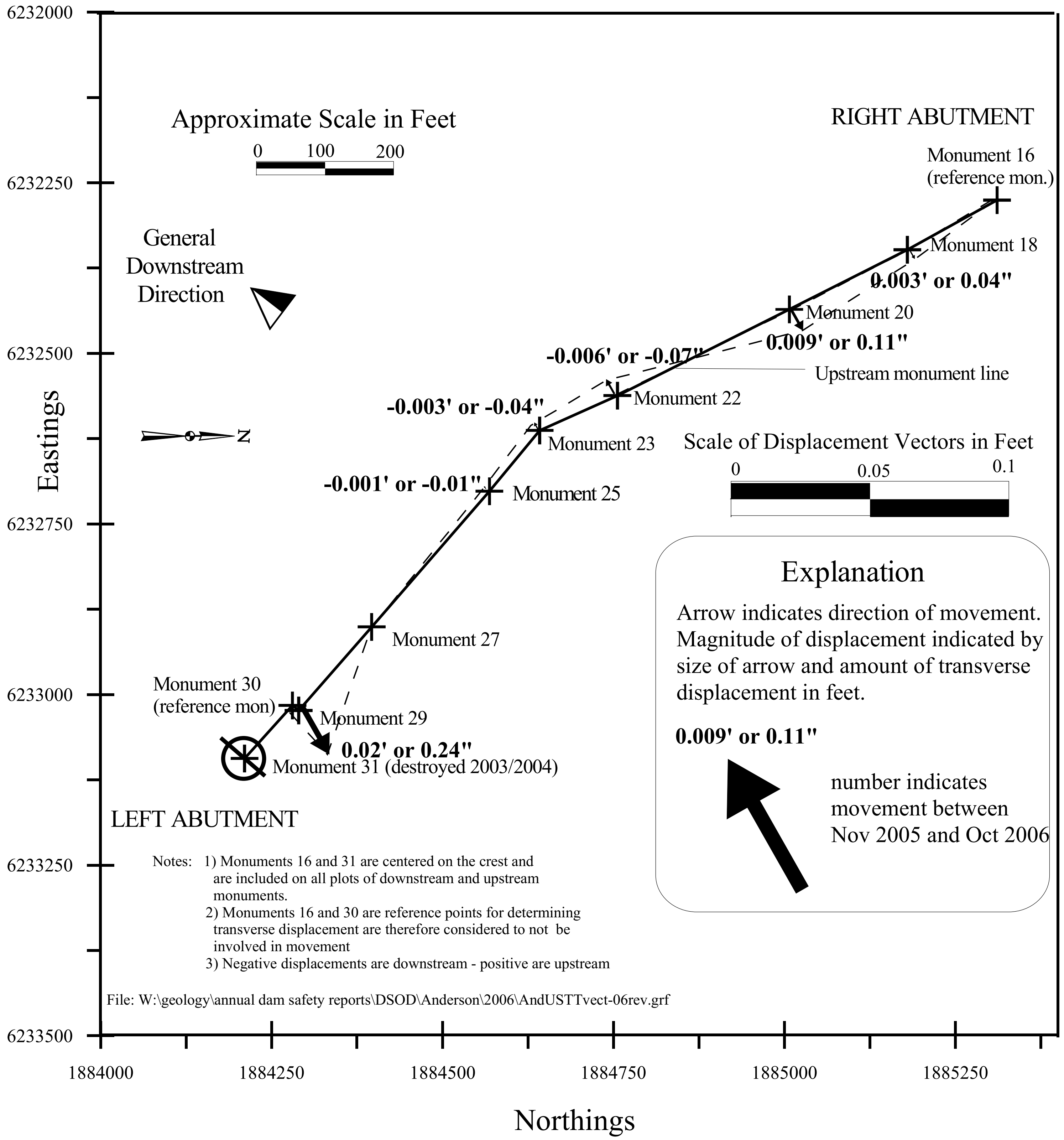
Notes:
1) Monuments 16 and 31 are centered on the crest and are included on all plots of downstream and upstream monuments.
2) Monuments 16 and 30 are reference points for determining transverse displacement are therefore considered to not be involved in movement
3) Negative displacements are downstream - positive are upstream

File: W:\geology\annual dam safety reports\DSOD\Anderson\2006\AndDSTTvect-06rev.grf

Figure 13 - Nov 2005 to Oct 2006 Local Transverse Displacement Vectors - Monuments at Downstream Edge of Crest

LEROY ANDERSON DAM (No. 72-9)

Santa Clara Valley Water District



Explanation

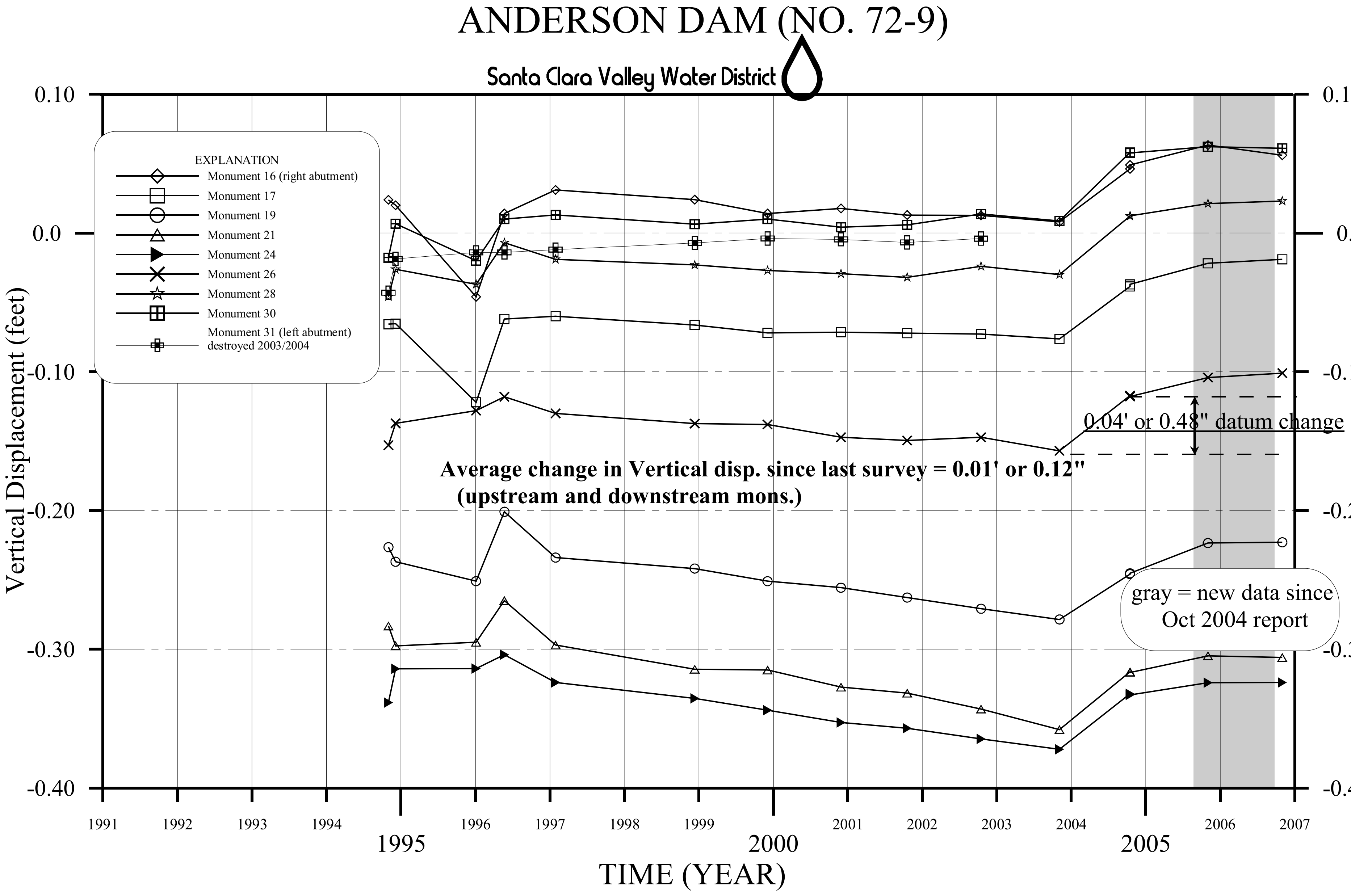
Arrow indicates direction of movement. Magnitude of displacement indicated by size of arrow and amount of transverse displacement in feet.

number indicates movement between Nov 2005 and Oct 2006

Notes:
1) Monuments 16 and 31 are centered on the crest and are included on all plots of downstream and upstream monuments.
2) Monuments 16 and 30 are reference points for determining transverse displacement are therefore considered to not be involved in movement
3) Negative displacements are downstream - positive are upstream

File: W:\geology\annual dam safety reports\DSOD\Anderson\2006\AndUSTTvect-06rev.grf

Figure 14 - Nov 2005 to Oct 2006 Local Transverse Displacement Vectors - Monuments at Upstream Edge of Crest



File W:\geology\annual dam safety reports\dsod\anderson\2006\andvert1-06.grf

Figure 15 - Vertical Displacements - Monuments at Downstream Edge of Crest

ANDERSON DAM (NO. 72-9)

Santa Clara Valley Water District

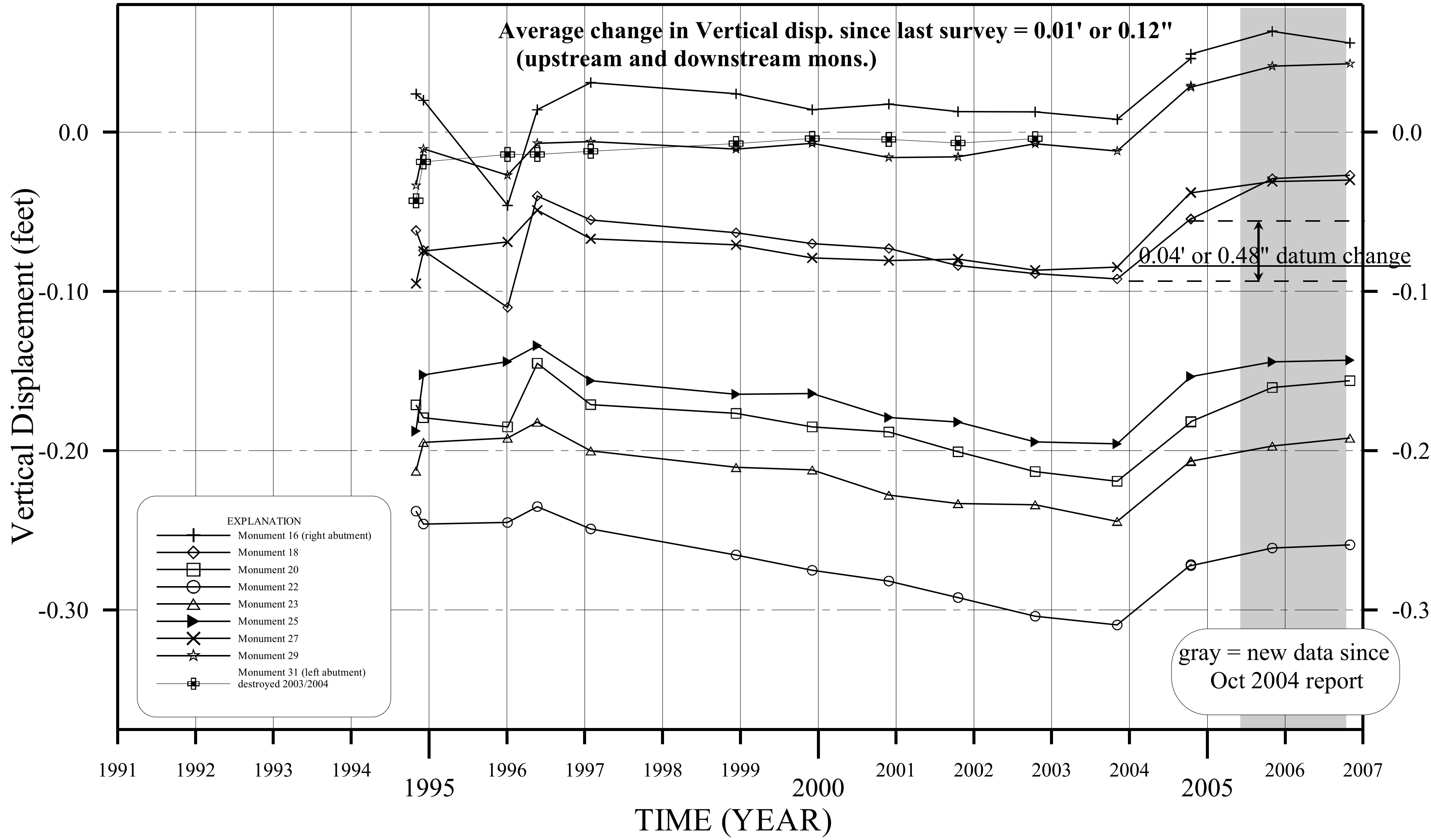


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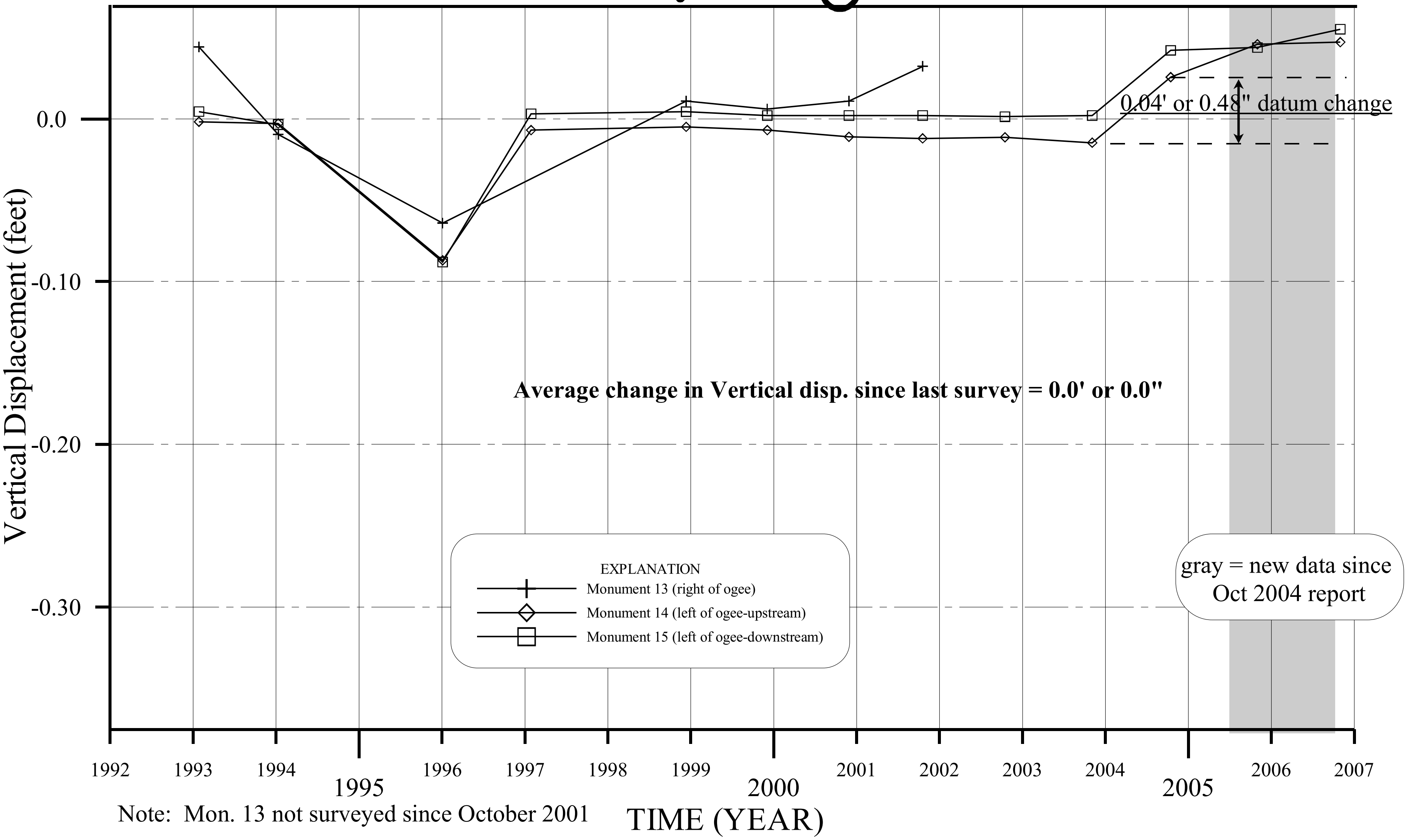
Figure 16 - Vertical Displacements - Monuments at Upstream Edge of Crest

ANDERSON DAM (NO. 72-9)

Santa Clara Valley Water District



Note: Mon. 13 not surveyed since October 2001

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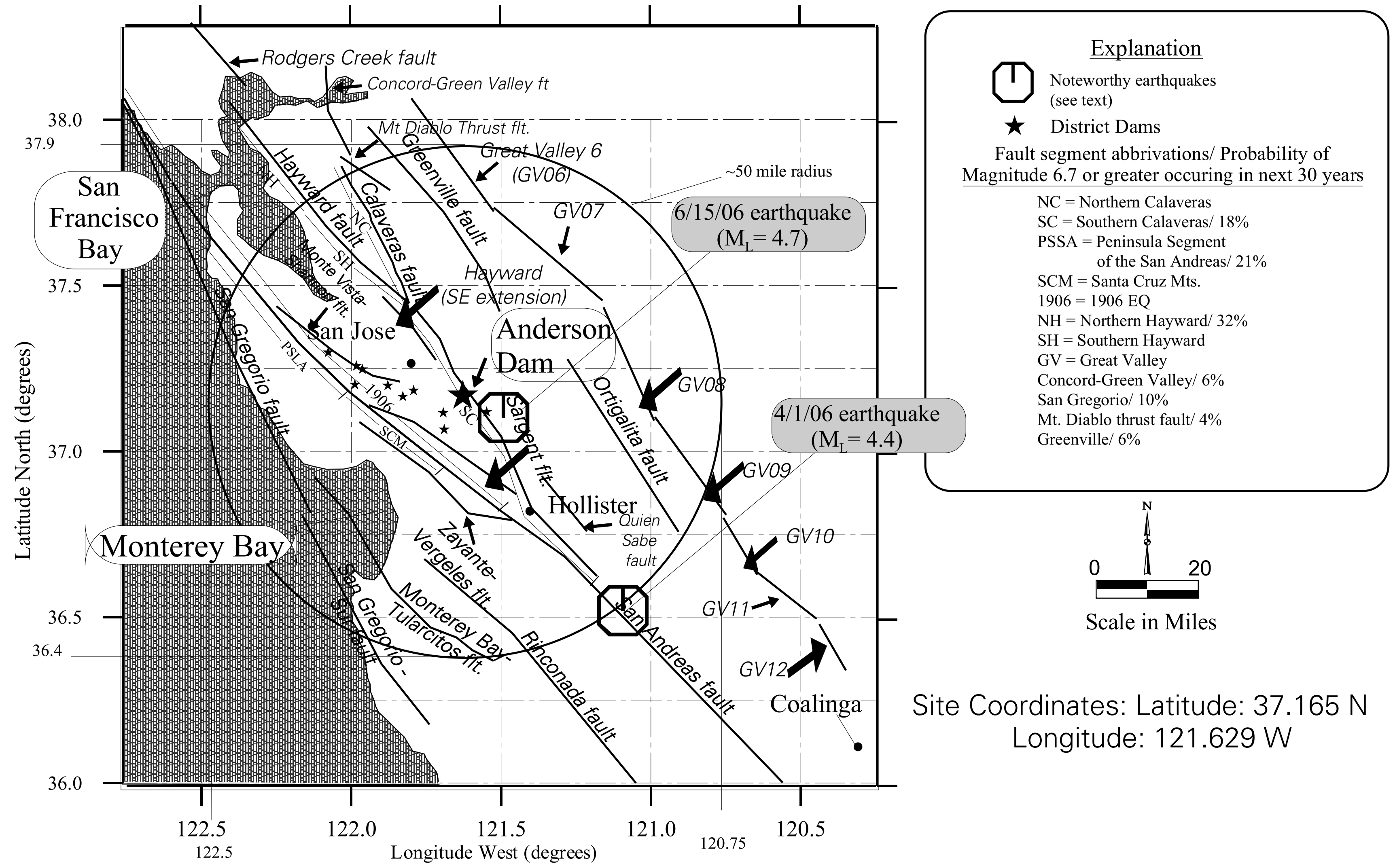
Figure 17 - Vertical Displacements - Spillway Training Walls



Explanation

Noteworthy earthquakes (see text)

★ District Dams

Fault segment abbrivations/ Probability of Magnitude 6.7 or greater occuring in next 30 years

NC = Northern Calaveras
SC = Southern Calaveras/ 18%
PSSA = Peninsula Segment of the San Andreas/ 21%
SCM = Santa Cruz Mts.
1906 = 1906 EQ
NH = Northern Hayward/ 32%
SH = Southern Hayward
GV = Great Valley
Concord-Green Valley/ 6%
San Gregorio/ 10%
Mt. Diablo thrust fault/ 4%
Greenville/ 6%

Site Coordinates: Latitude: 37.165 N
Longitude: 121.629 W

Notes: 1) File W:\geology\dams\annual dam safety reports\DSOD\Anderson\2006 report\Andseis-06.grf

DATE	12/11/02
DESIGN	JLN
DRAWN	JLN
CHECKED	RLV

Santa Clara Valley Water District

Regional Fault Map, Showing Noteworthy Earthquakes

Anderson Dam (No. 72-9)

SCALE
1"=20'

FIGURE
18